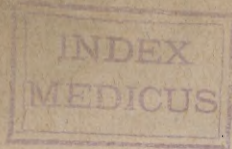


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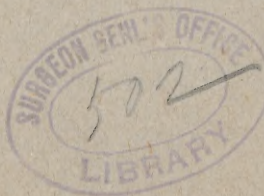
ENTERORRHAPHY; ITS HISTORY, TECHNIQUE AND PRESENT STATUS.

President's Address, delivered at the Meeting of the Association of Military Surgeons of the National Guard of the United States, Chicago, August 8, 1893.

BY N. SENN, M.D., PH.D., LL.D.

President, Association of Military Surgeons of the National Guard of the United States; Professor of Practice of Surgery and Clinical Surgery, Rush Medical College; Professor of Surgery, Chicago Polyclinic; Attending Surgeon Presbyterian Hospital; Surgeon-in-Chief St. Joseph's Hospital, Chicago.

Reprinted from "The Journal of the American Medical Association," August 12, 1893.



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Enterorrhaphy; Its History, Technique and Present Status.

A study of surgical literature brings the conviction that the successful treatment by direct operative intervention of injuries and surgical affections of the intestinal tract is one of the most brilliant achievements of modern surgery. Less than fifty years ago many of the most famous surgeons regarded the direct treatment of wounds of the intestines as a *noli me tangere*, under the belief that nature's resources would prove more successful in saving the life of the patient than the surgeon's efforts in closing the wound by artificial means. The intentional infliction of an intestinal wound by the surgeon for the purpose of correcting mechanical difficulties anywhere in the intestinal canal and the removal of life-threatening affections by operative procedure are subjects which have been seriously discussed and extensively practiced only during the last twenty-five years. It is advisable and profitable during the present time that has witnessed such wonderful advancements in surgery to make occasionally a halt in the restless search for new discoveries and novel operations to take a retrospective view of what has been done in the past in certain departments of surgery that have recently been subjected to such complete revolutionary changes. No part of abdominal surgery has undergone more radical changes than the intestinal suture, and in none is the contrast greater between the ancient and modern methods. I have deemed it advisable on this occasion to give you, in place of a general address, as brief a resumé as possible of the history, technique and present status of enterorrhaphy.

HISTORY AND TECHNIQUE.

The history of the intestinal suture is full of interest to the student of surgical literature. It is replete with stupendous ignorance, clever mechanical ingenuity, patient experimental research, and the careful application of pathological knowledge to the treatment of injuries and diseases of the intestinal canal. From an anatomico-practical standpoint the history of the intestinal suture can be divided into three epochs: 1, ancient; 2, modern; 3, recent. The ancient history extends back from Lambert (1826) to the time of Celsus. The modern history commenced with the researches of Lambert, which proved that healing of intestinal wounds takes place most constantly and speedily if the serous surfaces are brought and kept in contact by the sutures. The third period was initiated by the introduction of the aseptic suture by Lister, and will necessarily extend far into the future. We have reason to believe that

the technique of intestinal suturing remains an unfinished chapter, and that the ideal method of uniting intestinal wounds has yet to be devised.

I—ANCIENT METHODS.

Celsus mentions the intestinal suture, but speaks disparagingly of its use. It is probably on this account that the subject did not receive any attention until Abulkasem (II, 87) again revived it. This author recommended the jaws of large ants with which to unite the wound, and also refers to catgut made of the intestine of the sheep as a suturing material. The oldest suture, and the one to which nearly all of the old authors refer, is undoubtedly the glover's suture. This suture was intended to approximate the cut margins of the intestinal wound in the same manner as any ordinary wound, and was used for the double purpose of preventing the escape of intestinal contents, and of keeping the visceral in close contact with the external wound, consequently the two ends of the suture were brought out of the external wound and fastened in some way upon the surface of the abdomen until the time had expired when it was deemed safe to remove the thread.



Fig. 1. Glover's suture used for uniting wounds of the intestines. AA, the intestine; BB, the wound; C, the beginning of the suture, with part of the thread hanging out; D, the end of the suture, where it is fastened in a knot.

Figure 1 is taken from Heister's Textbook of Surgery, translated by Hollingsworth, 1739, and represents the glover's suture as applied by the ancient surgeons. Roger, Jamerius, and Theodorich of Serbia, inserted into the bowl a hollow cylinder of elder over which the wound was united by sutures. The cylinder was used for the purpose of keeping the lumen of the intestine patent. Wilhelmus v. Saliceto (Cervata, Chir. Venet., 1520, page 107) used a segment of the dried intestine of an animal with the same object in view. Later, he agreed with his colleagues that the best material to assist the suturing would be the dried trachea of a goose or some larger animal, and thus originated the suture of the four masters. The foreign substance was not fastened in

the bowel; after its insertion into the lumen the margins of the wound were united by ordinary interrupted sutures, which embraced the entire thickness of the intestinal wall and the ends of which were left long and were brought out of the external wound.

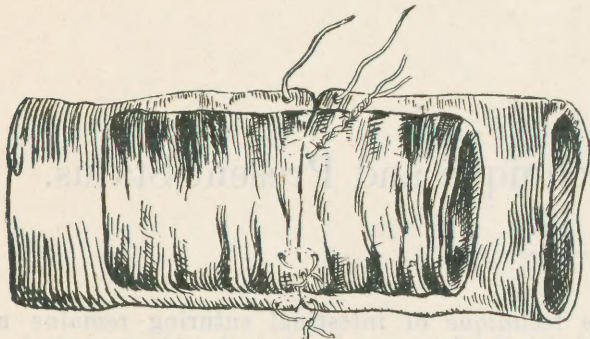


Fig. 2. Suture of the four masters.

The process of the ancients, however, had attracted so little attention that Du Verger, who revived it at the beginning of the last century, considered himself its author. It would not appear, moreover, that it had been frequently made trial of, or that it proved successful more than two or three times.

Du Verger modified the suture of the four masters by including the tracheal cylinder in the sutures as is shown in Fig. 3. Sabatier substituted for the

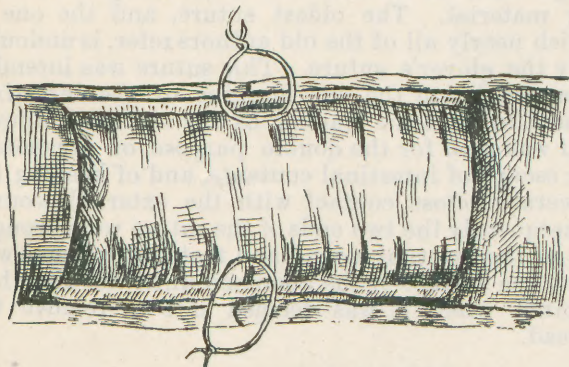


Fig. 3. Suture of Du Verger. Sutures including the tracheal cylinder. trachea a cylinder of cardboard which he besmeared with sweet oil, essence of turpentine, or oil of St. Johnswort.

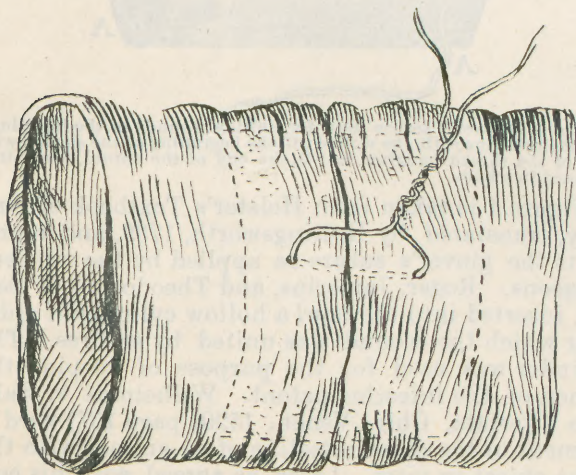


Fig. 4. Suture of Sabatier.

Sabatier used only one stitch in fastening together the two ends of the bowel and the cardboard cylinder, as will be seen by the accompanying illustration.

The four masters used four stitches, Du Verger two, Sabatier one; when Ritsch ("Transactions of the Academy of Surgery," Paris, vol. i) modified the procedure still further by passing the thread from side to side through the center of the bowel and the cylinder, when the ends were twisted and brought out of the external wound.

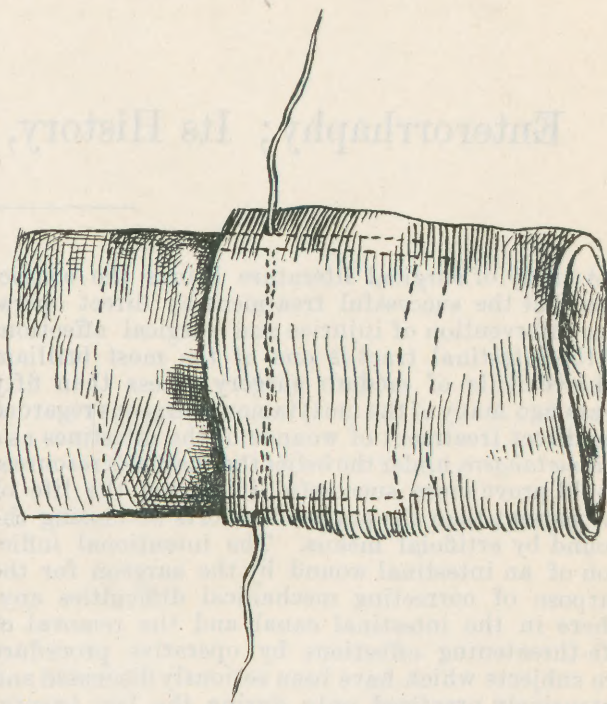


Fig. 5. Suture of Ritsch.

Watson ("Medical Communications," Vol. ii) recommended a cylinder of fish glue. His experiment on a dog proved successful. Ph. von Walther advised a tube of India rubber.

It is not surprising that the methods of suturing heretofore described did not add to the reputation of intestinal surgery, and that many of the most prominent surgeons of that time opposed closure of intestinal wounds by artificial means.

Guy de Chauliac approved of the suture only in the treatment of wounds of the large intestine, for which he recommended the glover's suture. Vigo, Fallopius and Fabricius ab Aquapendente regarded wounds of the small intestines as absolutely fatal.

Hieronimus Braunschweig (Das Buch der Chirurgia, Strassburg, 1497) alludes to Galen and others as opposing the intestinal suture. He is in favor of the procedure and advises the glover's stitch in preference to the ordinary suture. After suturing the intestine he cleansed the part and applied a powder of equal parts of mastich, tragacanth, and gum arabic. He relates a remarkable case which occurred in the practice of Saliceto, one of the four masters. A cavalier of Papia (Pavia) stabbed himself in the abdomen with a knife in such a manner that the intestines prolapsed. A longitudinal wound of the intestine was found. Master Ottebanus of Papia was called, who pronounced the injury a fatal one. Owing to the swelling of the protruded intestines he failed in effecting reduction. Saliceto was called in consultation who cleansed the intestines, sutured the wound, enlarged the abdominal opening, reduced the mass and saved the would-be suicide.

In 1686 Richard Wiseman ("Chirurgical Treat-

ises," second edition, London, 1686, p. 372), the great English surgeon, writes on this subject as follows:

"If in such a penetrating Wound the small guts be wounded, the vehement Pain, continual vomiting of Choler, and dejection of Chyle by the Wound, will discover it; but in that case, the keeping of it open to seek the Intestine will be a hard task; and when you have found it, what will it signifie, to embrocate all the Region of the Belly with Ol. mastich lumbric, to dress the wound with Sarcoticks, and to keep it close and warm with Compress and Bandage. But if the great Intestines be wounded, and the Excrements discharge that way, it may be reasonable to lay open the Wound, and stitch the Gut with the Glover's stitch, sprinkling it with some of the aforesaid Agglutinatives; and reducing it back, stitch up the external Wound of the Belly, as hath been said."

It appears that more than fifty years later the consensus of opinion among surgeons in reference to the utility of the direct treatment of intestinal wounds had not undergone any material change if we rely on another eminent authority of that time. Heister in his classical work on Surgery (Hollingsworth's Translation, 1739) cautions not to suture intestinal wounds smaller in diameter than a goose-quill, after which he continues:

"But large Wounds of the Intestines, though they seldom admit of Cure, are to be stitched up with the Glover's suture, before the Intestine is returned. To perform this, you should be provided with a fine Needle threaded with Silk, an Assistant should take hold of one part of the Gut, with a fine piece of Linen well aired before the Fire, whilst the Surgeon should hold the other part in his Left hand, and sew up the whole wound after the Glover's manner, leaving very small spaces between each Stitch, to-wit—a little more than a mathematical line. The last Stitch should hang out about a foot out of the Abdomen, by which the Silk may be drawn out when the Intestine is healed."

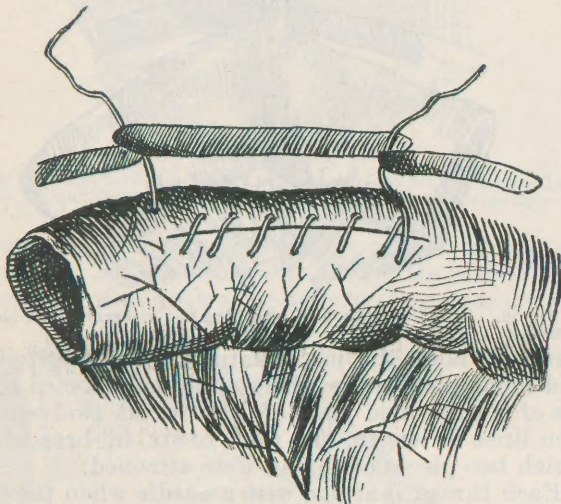


Fig. 6. Heister's method of applying the glover's suture.

After alluding to several other kinds of sutures, he gives his estimate of the value of suturing intestinal wounds: "But, to say the truth, Experience shows us that very few are saved, whatever Suture is made use of." In complete transverse wounds he advises the formation of an artificial anus.

Purmann (Feldscherer, etc., Frankfurth u. Leipzig, 1730) in his military surgery recommends suturing with silk or catgut, using the continued or glover's stitch. The catgut prepared from the intestines of sheep he immerses in wine over night before using it. He also refers to the shoemaker's stitch, but in his own practice always resorted to the glover's suture. In the after-treatment he advises mild cathartics and turpentine injections.

Mr. Samuel Sharp ("A Treatise on the Operations of Surgery," etc., London, 1769) gives the following directions in the use of the glover's suture:

"Upon the Supposition of the Intestine being wounded in such a manner as to require the Operation, the Method of doing it may be this: taking a straight needle with a small Thread, you lay hold of the Bowel with your left hand, and sew up the wound by the Glover's stitch, that is, by passing the Needle thro' the lips of the Wound, from within outwards all the way, so as to leave a Length of Thread, at both Ends, which are to hang out of the incision of the Abdomen, then carefully making the interrupted Suture of the external wound, you pull the bowel by the small Threads into Contact with the Peritonæum, in order to procure an Adhesion, and tye them upon a small Bolster of Linen; tho' I think it would be more secure to pass the Threads with the straight Needle through the lower Edges of the Wound of the Abdomen, which would more certainly hold the Intestine in that Situation. In about six days, it is said the ligature of the intestine will be loose enough to be cut and drawn away, which must be done without great force; in the Interim, the wound is to be treated with superficial dressings, and the Patient to be kept very still and low."

During the close of the first decade of this century Zang (*Darstellung blutiger heil künstlerischer Operationen*, etc., Wien, 1818) entertained the most extreme pessimistic views in reference to the value of the intestinal suture as is evident from the following sentence: "Every intestinal suture is a mighty procedure in a highly vulnerable organ, and therefore a dangerous, yes, a very dangerous undertaking." As the most convincing proof of its harmful action, he claimed that the mortality following its use was much greater than when the process of repair is left to nature's resources.

The bad results which followed suturing of intestinal wounds in the hands of the ancient surgeons as well as the observation made that occasionally cases recovered without any aid on the part of the attending surgeon, led the way to the most conservative treatment. It was generally conceded that spontaneous recovery occurred when the visceral wound was in such a locality that no extravasation occurred into the peritoneal cavity, and the wound became adherent to a serous surface, notably the parietal peritoneum. Spontaneous recovery from complete transverse wounds of the intestine by adhesion of the margins of the proximal end to the external wound was observed by Hildanus, Blegny, Dionis, Palfyn, Joh. Maur, Hoffmann, Seebacher, Vater, Cheselden and others. This induced surgeons to imitate nature's processes by bringing the intestinal wound or the ends of the divided bowel into the external wound, in which position the wounded intestine was fastened by passing a thread through the mesentery, and fastening it upon the surface of the abdomen. This operation was first performed successfully on a dog by Blegny (*Zodiac*, Gall. Au. 2, p. 143). Schacher (*Programm Publico*, Leipzig, 1720) reported the first successful operation of this kind on man. Verduc and von de Wyl were opposed to the intestinal suture and advised the formation of an artificial anus, especially in cases of transverse wounds.

It is probable that Paracelsus was the first to propose this method of treatment. Palfyn rejected all kinds of intestinal sutures and advised that in all wounds of the intestine easily accessible, the visceral wound should be brought in close contact with the external wound and the intestine held in this position by a thread passed through the mesentery until the intestine became firmly adherent to the abdominal wall.

Palfyn's method of fixation of the intestine against the abdominal wall is illustrated by Fig. 7.

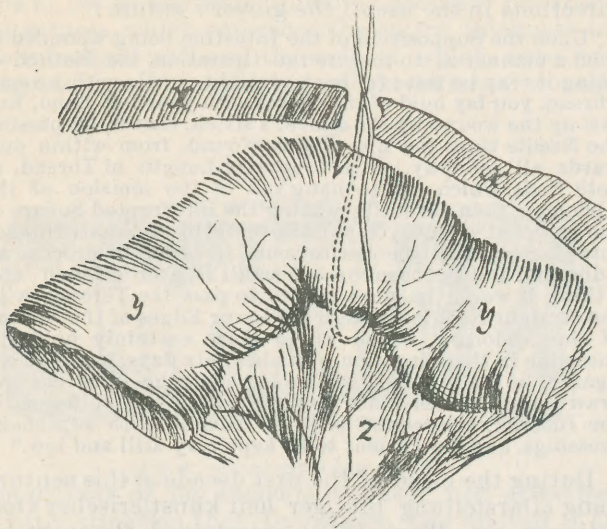


Fig. 7. Palfyn's method of treating intestinal wounds. *a*. Thread passed through mesentery and surrounding the bowel. *y*, Intestine. *z*, Mesentery. *x*, Abdominal wall.

As the traction by the mesenteric ligature must have caused narrowing of the bowel, Palfyn's method was modified so as to obviate this difficulty by passing the needle and thread twice through the mesentery and bringing both ends of the thread out through the external wound on each side of the bowel as is shown by Fig. 8.

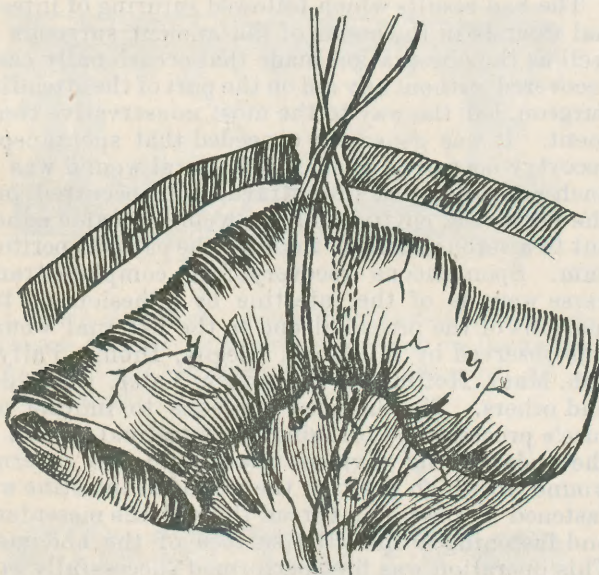


Fig. 8. Modification of Palfyn's mesenteric loop.

De la Peyronie's ("Mem. de l'Academ. de Chirurgie," T. III, 1733) method differed somewhat from Palfyn's, in that he stitched the bowel at the same time to the margin of the external wound. Other surgeons dispensed with the mesenteric loop entirely and fastened the injured part of the bowel to the inner surface of the abdominal wall by a suture which embraced both lips of the visceral and parietal wounds.

In complete transverse wounds of the intestine Benj. Bell recommended that each end of the bowel should be fastened to the corresponding margin of the external wound by an interrupted suture.

Reybard ("Mémoires sur le traitement des anus arti-

ficiels, des plaies des intestins et des plaies pénétrantes de poitrine," Paris, 1827) maintained that

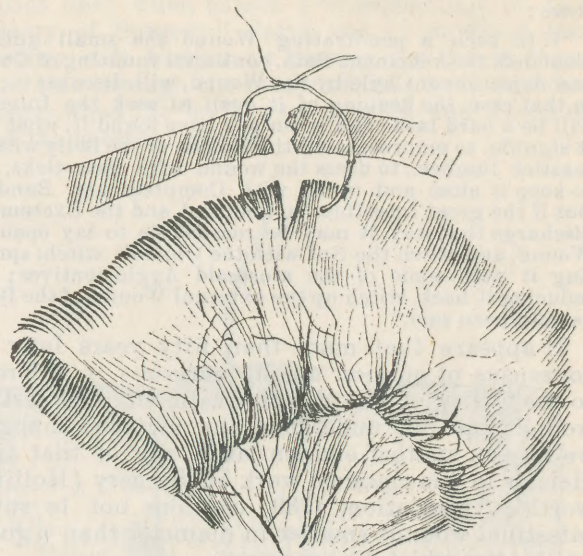


Fig. 9. Fixation of injured bowel to abdominal wall by a single suture.

the principal object of the intestinal suture is to bring the visceral wound in contact with the inner surface of the abdominal wall and the external wound, thus securing healing of both wounds by adhesions, and acting on this supposition he devised an exceedingly ingenious plan in accomplishing this

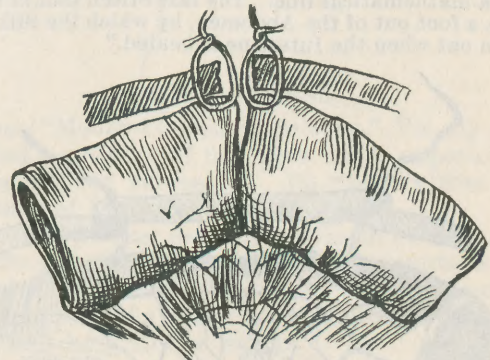


Fig. 10. B. Bell's method of attaching the visceral to the parietal wound.

result without the use of sutures. In longitudinal and incomplete transverse wounds he resorted to the use of a thin oiled plate of light wood, twelve to fifteen lines in length, and four to six in breadth, to which two pieces of thread were attached.

Each thread is armed with a needle when the plate is inserted into the bowel through the wound, and the needle with the thread attached is passed through the entire thickness of the abdominal wall and brought out on the surface near the margin of the external wound. When both threads are in place they are tied together in such a manner that the small plate of wood presses at the same time the two lips of the intestinal wound against the sides of the abdominal wound, which latter it also at the same time keeps hermetically closed. When the adhesion of these different tissues appears to have become sufficiently firm (usually the third day), the threads are cut; the little plate of wood is released and passes away with the stools.

There can be no question that the intentional formation of an artificial anus in the treatment of in-

testinal wounds, so strongly advocated by Scarpa ("An. Chir. Abh. über die Brüche," Leipzig, 1892, p. 280; translated by Seiler from the Italian), and many of his contemporaries, yielded much better results as a life-saving measure than the old-fashioned suture. We have reason, however, to believe that in many instances in which life was saved the artificial anus remained permanently, constituting a great annoyance, and often an additional source of danger throughout the balance of the lifetime of the survivor. The great mortality attending this procedure and this remote sequence undoubtedly aroused surgeons to devise new methods of suturing. So firmly had the opinion gained ground that intestinal wounds could not heal by direct union that v. Walther (System der Chirurgie, Freiburg, 1851), as

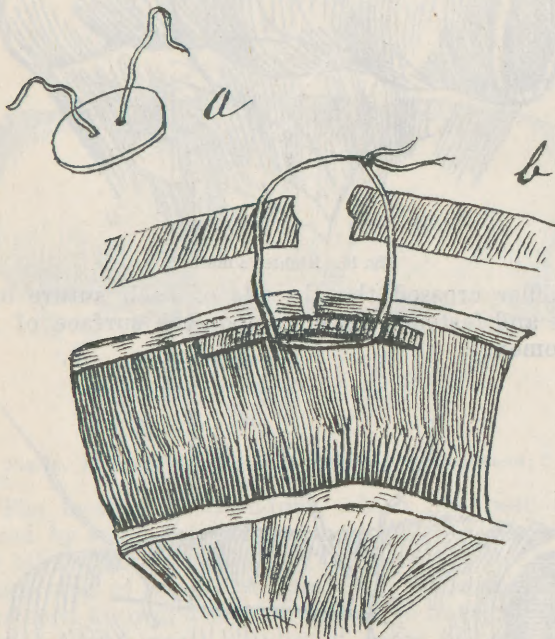


Fig. 11. Reybard's method. a, Plate of wood with two threads; b, plate in situ and fastened to abdominal wall by a suture including plate wall of bowel and abdominal wall.

late as 1851, asserted that healing always takes place by parietal or omental adhesions. He insists that Larrey was wrong when he asserted the contrary and

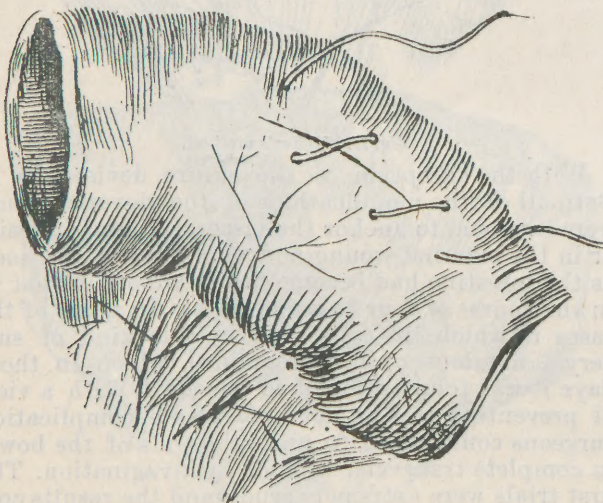


Fig. 11 a. Suture after Garengéot.

excuses his mistake by asserting that when he made his observations he did not have the necessary ma-

terial to enable him to arrive at correct conclusions. The next class of sutures to be described resembles the old-fashioned glover's suture in so far that the different sutures were intended to prevent the escape of intestinal contents, and at the same time by leaving the threads long they could be utilized in anchoring the visceral against the ventral wound.

Garengéot modified the ordinary glover's suture only in so far that he placed the stitches farther apart.

Larrey ("Revue Médicale, 1820, iv, p. 77) regarded a single row of the continued suture as unsafe and advised in its place two rows, using for each row threads of a different color, and making the stitches in opposite directions. He recommended removal of the two threads at the end of seven or nine days



Fig. 12. Larrey's double the glover's suture.

Benj. Bell feared the removal of the suture and objected to the ordinary glover's suture because he believed it produced dangerous narrowing of the lumen of the bowel. He modified the glover's suture in such a manner that he passed the needle from within outward terminating the thread at each end with a knot and cutting the thread short to the knots. He relied on the suture cutting its way into the lumen of the bowel to be discharged with the feces.

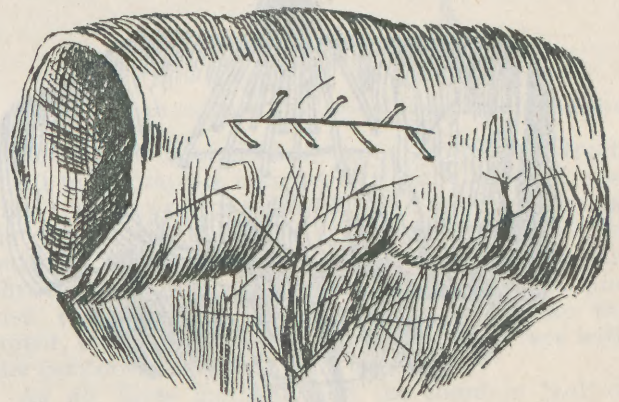


Fig. 13. B. Bell's suture.

Bertrandi and Petit devised the *sutura transgressiva*. It is made by bringing the margins of the wound in contact, passing the needle from right to left, then from left to right alternately and bringing both ends of the thread out of the external wound in order to bring both wounds in contact.

Le Dran ("Traité des Opérat.," Paris, 1743) takes as many threaded needles as stitches are required,

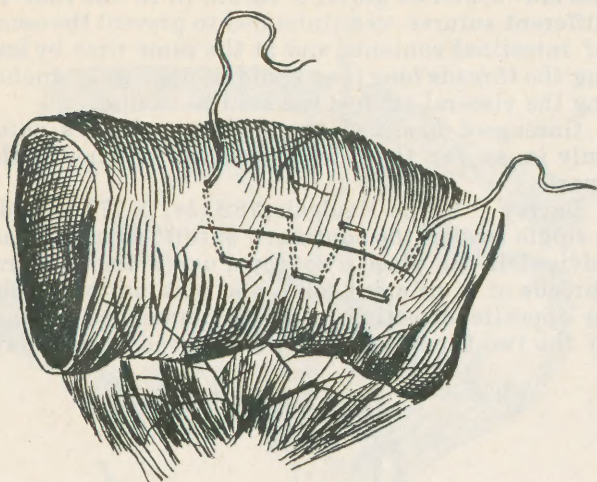


Fig. 14. Petit's sutura transgressiva.

and passes them three lines apart through both margins of the wound. Ties together the ends of the threads of each side and twists the two bundles of threads. The intestine is thereby puckered up and sutures approximated.

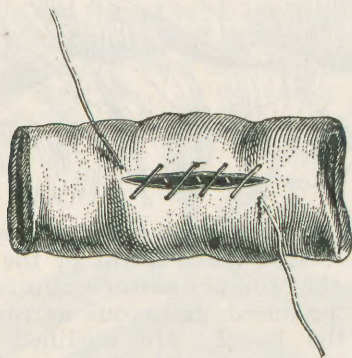


Figure 14 a.

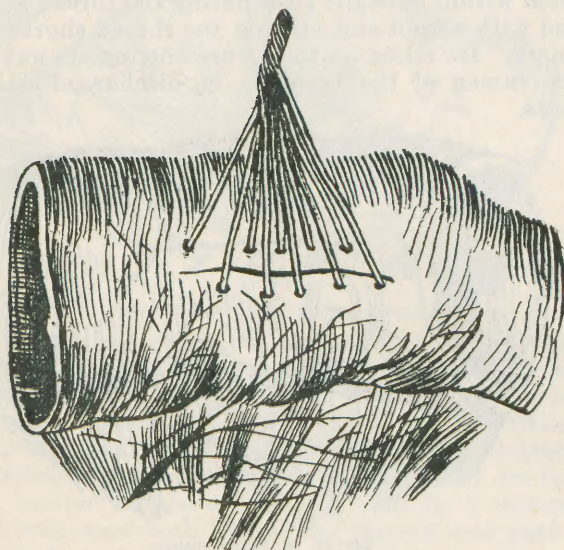


Fig. 15. La Dran's method.

He claims that by this procedure the intestinal wound is greatly diminished in size, and often heals without leaving a fistula; at the end of four to six days the threads are untwisted and removed. Richter twisted each suture separately without tying it

and brought them out of the external wound with which to fasten the bowel against the abdominal wall.

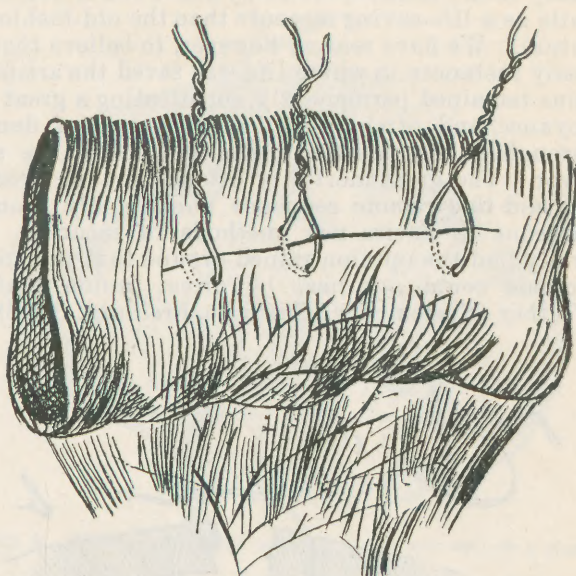


Fig. 16. Richter's method.

Löffler crossed the threads of each suture only once and fastened the ends upon the surface of the abdomen.

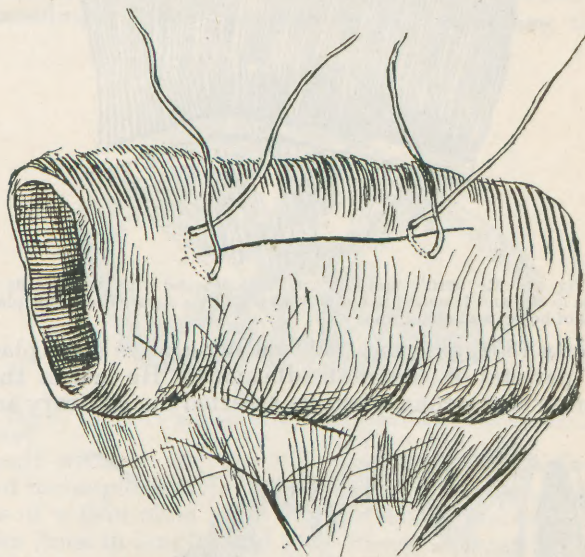


Fig. 17. Löffler's method.

With the exception of the suture devised by B. Bell, all of the modifications of the glover's suture were intended to anchor the visceral wound opposite or in the external wound and were removed as soon as the intestine had become firmly adherent, that is, in the course of four to seven days. In many of the cases in which life was saved by this kind of surgery a fistulous opening remained, which in those days it was found difficult to remedy. With a view of preventing this unpleasant remote complication surgeons commenced to unite the ends of the bowel in complete transverse wounds by invagination. The first trials were extremely crude, and the results correspondingly disastrous. Ramdohr recommended invagination as a means of uniting the ends of the intestine in complete transverse wounds as early as 1730. Having under treatment a soldier in whom

the continuity of the intestinal tube had been destroyed, he proposed to insert the upper into the lower end, to fasten them together in this position by means of one point of suture, then to reduce them and leave them in the abdomen, fastening the bowel to the abdominal wall by the suture. His patient recovered. As he died some years after of some other affection, Ramdohr being thus enabled to examine the condition of the parts, removed the portion which had been formerly divided, and sent it to Mœbius, who took occasion to show it to Heister, which latter upon the strength of this, made experiments of the same operation on dogs, but without success.



Fig. 18. Ramdohr's method of invagination. O, upper end; U, lower end.

The method of Ramdohr, which has been eulogized by some, rejected as impossible or dangerous by others, admitted as very ingenious by Louis, and made trial of in a great number of instances since it has been known, does not appear to have succeeded but in a very small number of cases. Louis aimed to improve Ramdohr's method by detaching the mesentery from the upper end to the extent of the intended invagination for the purpose of guarding more effectually against disinvagination.

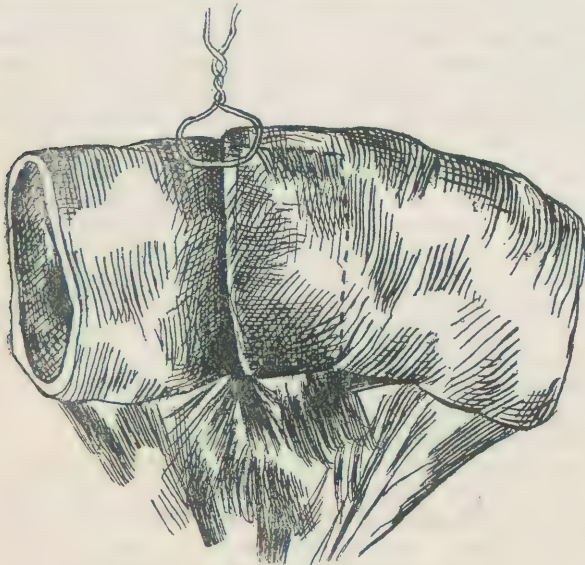


Fig. 19. Method of invagination of Louis.

Benj. Bell inserted a solid cylinder of tallow into the upper end of the bowel before making the invagination,

and fastened the bowel with two rows of interrupted sutures which included the entire thickness of both intestinal walls at each cut end of the bowel.

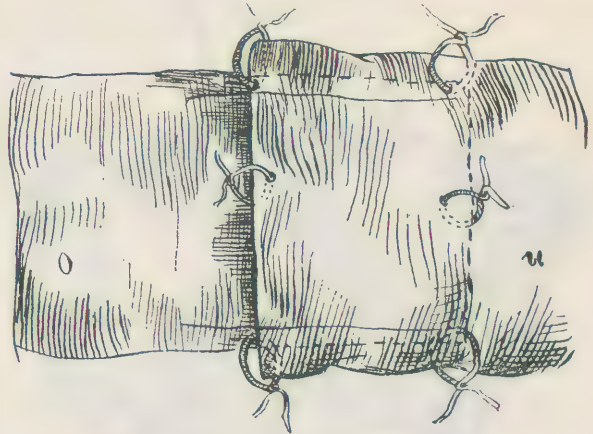


Fig. 20. Benj. Bell's method of invagination.

Chopart and Desault, recognizing the difficulties encountered in making the invagination, lined the upper end of the bowel with a cylinder of cardboard which was included in a single ligature passed through the bowel from side to side, when both ends of the thread were passed with a needle in the lower end from within outward, when the invagination was effected by making traction upon the threads and the invagination maintained by fastening the threads upon the surface of the abdomen.

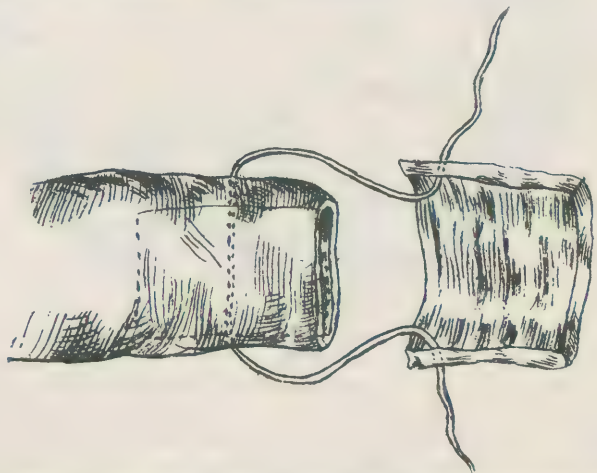


Fig. 21. Chopart and Desault's method of invagination in complete transverse wounds.

These authors applied the same principle of treatment to incomplete transverse wounds of the intestine. The upper margin of the wound was transfixed by a single suture transversely from within outward, when the ends were passed with a needle through the lower margin from within outward and tied, making thus the lower margin overlap the upper, bringing in contact its mucous surface with the peritoneal surface of the upper.

As all these methods had the common fault of approximating mucous membrane with peritoneum, it is not difficult to understand that none of them survived the practical test for any length of time. The seriousness of this technical mistake was first pointed out by Richerand. The researches of Bichât have shown that mucous membranes do not contract adhesions with each other; and that adhesive inflam-

mation takes place most surely and speedily between serous surfaces.

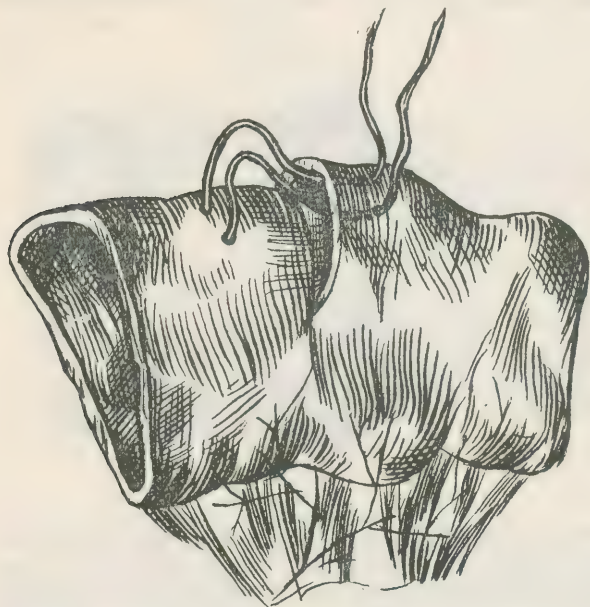


Fig. 22. Chopart and Desault's method of uniting transverse wounds of the intestine. a, Suture in place; b, suture tied.

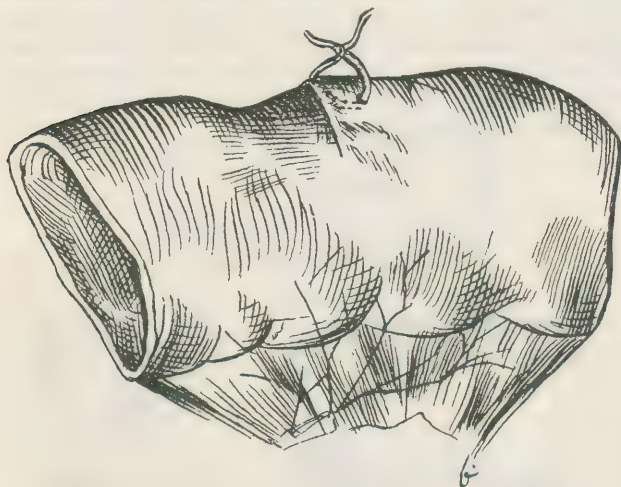


Fig. 22 b.

Travers ("An Inquiry into the Process of Nature in Repairing Injuries of the Intestines," London, 1812) experimented with the old suture including all of the tunics of the bowel, but cut the threads short to the knot and did not fasten the intestine against the abdominal wall as had been the general custom up to that time. He found that the intestinal wounds in animals thus treated usually healed. The sutures cut their way through the tissues in the direction of the lumen of the bowel and passed away with the feces. He placed the sutures very closely so as to secure ample mechanical protection against the escape of fluids, while Astley Cooper placed them much farther apart, using only a sufficient number to prevent fecal extravasation. In small wounds and limited gangrene Astley Cooper made a small cone on the affected side of the bowel by seizing the wound or gangrenous patch and applied a ligature of fine silk around the base. The ligature cut its way into the bowel during the time the defect became sealed by plastic lymph. The necrosed mass and ligature escaped into the bowel through the defect made by the ligature.



Fig. 23. Astley Cooper's method of dealing with small wounds and circumscribed gangrenous patches.

II—MODERN METHODS.

The researches of Richerand, Bichât and Travers prepared the way for Lembert to institute a complete revolution in the application of the intestinal suture. Until his time the discovery that adhesions take place most rapidly between serous surfaces was ignored in the use of the intestinal suture, and if success followed the surgeon's efforts the result was attributable less to the suture than the circumscribed plastic peritonitis, the product of which buried the sutures and sealed the wound by a mass of plastic lymph. To Lembert is conceded almost by universal consent the credit of having established the modern doctrine concerning the healing of intestinal wounds. As is the case in all great discoveries, claimants for priority were not wanting. Jobert ("Arch. Gén. de Méd.," T. iv. p. 73) has claimed this honor; Faure ("Arch. Gén. de Méd.," T. x, p. 474) alleges that when he was a pupil of the Hospital of St. Louis, he had proposed before the year 1820, the approximation of serous surfaces in intestinal wounds. Denans ("Soc. Méd., de Marseilles," 1826) also mentions that the suggestions of his process were made without knowledge of the work done by Lembert and Jobert. Lembert claims that he published his first paper on this subject in 1825. ("Bull. de Ther.," T. ix, p. 325). Denans began his experiments in 1823, but they were not published until March, 1824, and the Archives for January of the same year, contain a description of the process of Jobert. There can be no question that through the labors of Lembert the new doctrine gained a firm foothold and was promptly adopted, not only by his countrymen, but by the surgeons in England and Germany. Lembert's technique and practice brought about a sudden transition from the ancient to the modern methods. Since his time a great variety of methods have been proposed with a common object in view; to bring into apposition the serous surfaces of the margins of the wound.

Lembert's work initiated the most important era in the history of the intestinal suture. He must always be regarded as the founder of modern successful intestinal surgery. The technique of intestinal work is still open to improvements, but the great principle inculcated by Lembert to rely on the serous coat in procuring early and permanent adhesions will never be rejected.

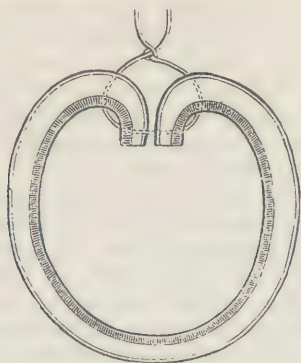


Fig. 24. Lember's suture.

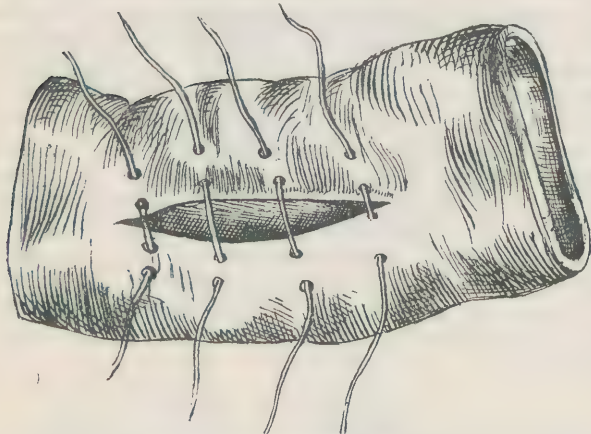


Fig. 25. Lember's sutures in place.

His first paper on this subject was published in 1826. (*Répertoire Général d' Anatomie et de Physiologie pathologique*, T. ii, 3, 1826). He used interrupted sutures of fine silk, and cut the threads short to the knot, making no provision for fastening the bowel against the abdominal wound. The point of the needle is introduced upon the external surface of the intestine at the distance of two or three lines from the margin of the wound; he penetrates through the tissues as far down as the mucous membrane, brings it out at one or two lines distance from its place of entrance; applies the needle with the same precautions upon the external surface and into the tissues of the opposite side. He places the sutures about three to four lines apart, and when they are all in place commences to tie from one end, turning the margins of the wound carefully toward the lumen of the bowel with a probe.

After completion of the suturing the part presents externally a linear depression with a corresponding

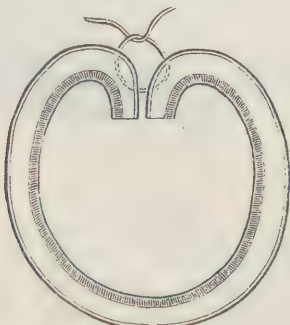


Fig. 26. Jobert's suture.

ridge on the inner side. This method secures serous approximation to the extent of space included by the sutures. The sutures become encysted and do

not cut their way into the lumen of the bowel. Lember's suture has been variously modified at different times. Jobert included in the suture the entire thickness of the wall of the bowel.

Breidenbach tied the knot on the inside of the lumen of the bowel.

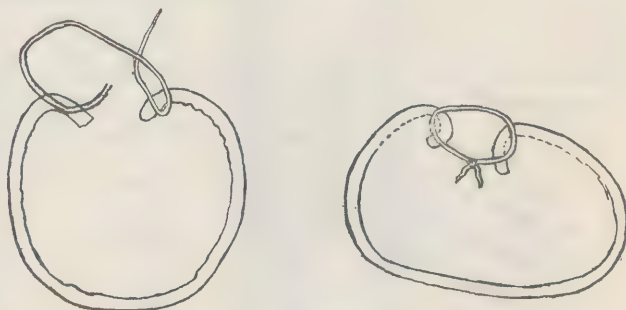


Fig. 27. Breidenbach's suture.

Dupuytren made the Lember stitch in the form of the continued suture.



Fig. 28. Dupuytren's suture.

Dieffenbach included in the suture only the peritoneal coat.

Gély (*"Recherches sur l'emploi d' un nouveau procédé de suture contre les divisions de l' intestin,"* Paris, 1844) armed each end of the thread with a needle. A loop is formed by transfixing the serous and muscular coats at one end on each side of the wound about 4 mm. from the margins of the wound, grasping about 5 mm. of surface. The needles and threads are then crossed and similar stitches taken and the process repeated until the opposite angle of the wound is reached, starting with the stitch at the subsequent point of exit of the needles. By making traction on the threads the margins of the wound are neatly inverted and only one terminal knot is required.

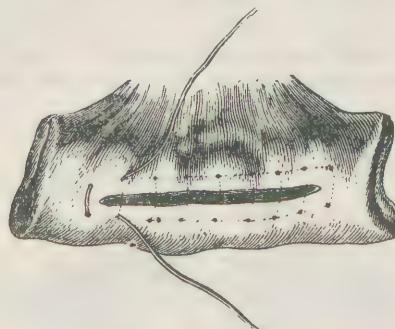


Fig. 29. Gély's suture.

According to Nélaton the advantages of this method are: that the sutures close the wound hermetically and that the thread can escape into the lumen of the bowel.

Blatin's modification of Gély's method consists in using only one needle and two threads of different color, first sewing with one and returning with the other, avoiding the punctures made by the first needle.

Emmert's ("Lehrbuch der Chirurgie," Stuttgart, 1862, p. 232) method of suturing intestinal wounds consists of a series of double Lembert sutures as is well illustrated by Fig. 30.

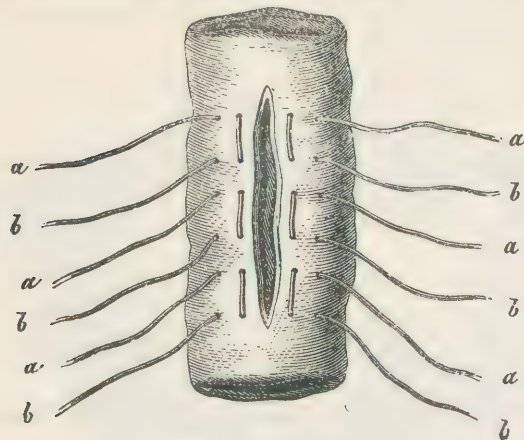


Fig. 30. Emmert's method.

When the sutures are all in place the corresponding threads on each side are tied and the margins of the wound are carefully inverted.

A very strange method of closing intestinal wounds was devised by Bouisson. Two insect pins of the length of the wound are pushed through the tissues parallel to and about 2 mm. from the margins of the wound. The pins are pushed in and out from the surface of the intestine in the same way as in making a continued suture. A ligature is passed under the free parts of the pins on each side at different points, and as they are tied the margins of the wound are inverted and approximated. All the threads are brought out of the external wound. On the third or fourth day the pins are withdrawn, thus releasing the ligatures which are also removed. Lembert's principle of uniting serosa to serosa was first applied in making the invagination suture by Jobert. ("Mémoires sur les plaies du canal intestinal," Paris, 1827). He modified Ramdohr's method by turning in the edge of the lower end before making the invagination, thus bringing serous surfaces in contact for adhesion. The invagination is made by inserting two sutures at opposite points in the upper end and passing the ends with a needle through the inverted margin of the lower end a few lines apart. By making traction upon the sutures invagination is effected and maintained by tying the sutures.

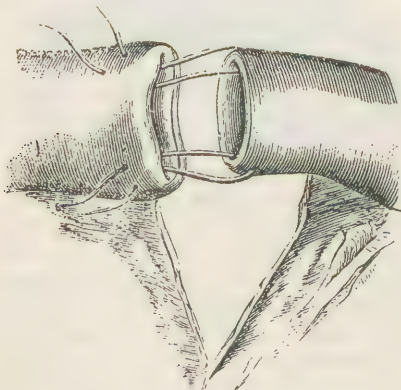


Fig. 31. Jobert's invagination suture.

Jobert's suture has had an extended trial in restoring the continuity of the bowel in the treatment of complete transverse wounds, and has yielded fair

results. The most objectionable feature to it is the fixation suture, which being composed of unabsorbable material must finally cut through the tissues which it includes before it can escape into the bowel, a process which is necessarily attended by no inconsiderable risk of extravasation and its consequences—septic peritonitis and death.

Schmidt, Thompson and Travers had observed the singular phenomenon, viz., that if a thread is applied around a small perforation of the intestine, it soon sinks into it as into a depression, in such a manner as to reach gradually the interior of the canal and to become entirely free there, at the same time that the serous coat or surface of the bowel is united behind it, and blended with a layer of plastic lymph as if intended to fill up the opening which, but for that, would have been left. Still more, Travers has found that if the entire caliber of the intestine is strangulated, the peritoneum of the upper portion adheres so rapidly to that of the deeper tissues, that the septum formed by the strangulation soon becomes gangrenous, and is detached and drawn in the direction of the lower part of the bowel in such a manner that the tube ultimately becomes perfectly re-established. Utilizing these facts as a basis, Amussat ("Casper's Wochenschrift f. d. Medicin," 1834, No. 44), made use of invagination and circular constriction in re-establishing the continuity of the intestinal canal.

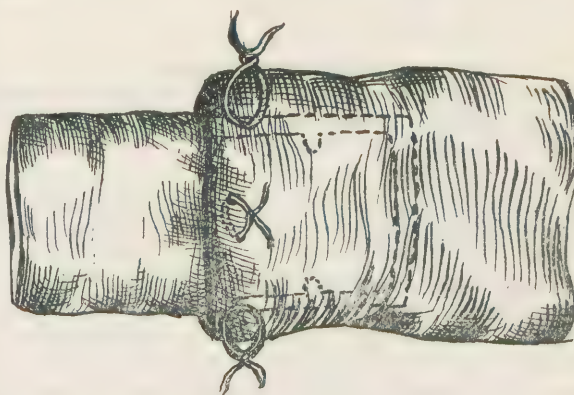


Fig. 32. Amussat's method of invagination and circular constriction. a, Invagination; b, circular constriction.

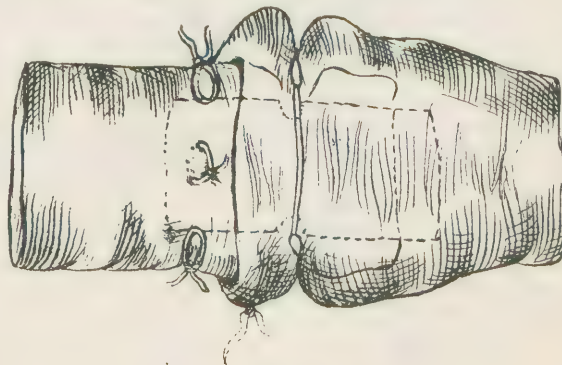


Fig. 32 a.

In order to maintain the patency of the bowel he inserted a hollow cylinder of elder into the upper end before making the invagination. This cylinder had a circular groove in the center. The invagination was maintained by a few sutures. A thread was then tied firmly around the bowel at a point corresponding with the circular groove. As soon as the string had cut its way into the bowel, the cylinder

was released and passed away with the feces, while the serous surfaces on each side of the groove made by the string became adherent.

Choise ("Thèse de Paris," 1837, No. 322), experimented on animals by inserting into the upper end a piece of the trachea of an animal, and after invaginating this into the lower end tied a ligature firmly around the invaginated portion. The ligature soon ulcerated through into the bowel, adhesions between the approximated serous surfaces formed in the meantime, and the ligature and tracheal ring escaped with the feces. The experiments on lower animals were successful. He later substituted a piece of cork for the trachea and obtained similar good results.

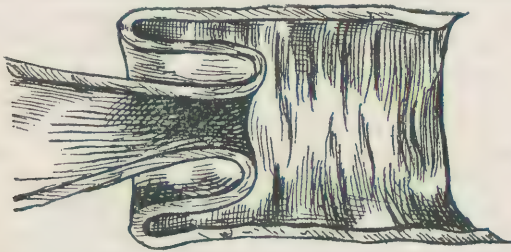


Fig. 33. Bécord's procedure. a, Invagination; b, circular constriction.

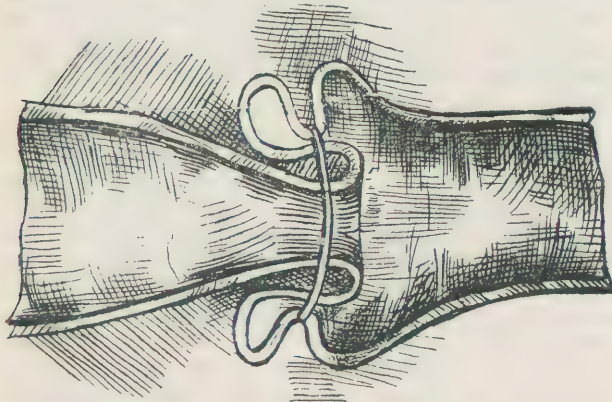


Fig. 33 a.

Bécord obtained the same results in his experiments on animals without the use of a cylinder.

After making the invagination he constricted the bowel by tying a thread firmly just below the margin of the ensheathing tube. Zang (op. cit.), detached the mesentery from the upper end to the distance of an inch, and invaginated this part into the lower end after turning in its margins. The invagination was maintained by a mesenteric suture which grasped both sides, the threads of which were brought out of the external wound and fastened so as to hold the invaginated part in the ventral wound. Various efforts have been made at different times to dispense with intestinal sutures by substituting for them some other kind of mechanical support. One of the earliest attempts in this direction was made by Denans ("Recueil de la Société roy. de Méd. de Marseille," l'Année. 1, 1826), a surgeon of Marseilles. The procedure is an exceedingly ingenious one. In effecting an end-to-end union in the treatment of complete transverse wounds or after resection, he introduces into each end of the bowel a ring of silver or zinc, over which he inverts the margins of the ends of the bowel and connects them by a slightly smaller but wider ring of steel which is cut longitudinally, the

margins overlapping so that it can be made smaller by pressure, and exert the necessary peripheral pressure to hold the other two rings firmly together. The central ring is compressed with a pair of strong forceps when it is first inserted into the upper end of the bowel, then into the lower, when the two rings are approximated over it, thus grasping firmly the inverted margins all around. The serous surfaces outside of the grasp of the rings become adherent, the inverted margins subjected to pressure between the rings slough, the rings are released and pass away with the stools.

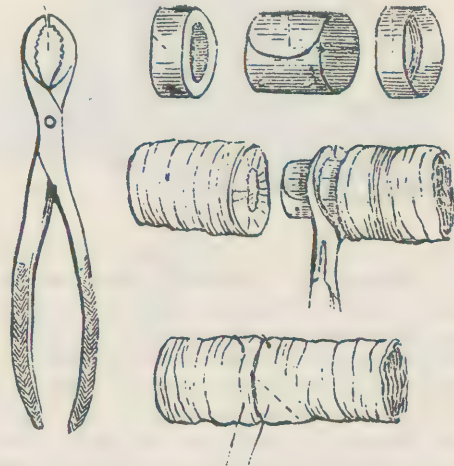


Fig. 34. Method of Denans. aa, Rings for bowel ends; b, connecting steel spring ring; c, upper end of bowel containing ring and proximal end of connecting ring; d, lower end of bowel containing ring, margin of bowel turned inward; e, two ends joined together; f, forceps to aid in the insertion of middle ring.

In his first experiments the connecting piece was a perfect ring, and in order to prevent separation of the ends of the bowel he used two points of suture, as will be seen in the illustration (e). Later ("Noté à l'Acad. de Méd.," 1838), he used the steel spring ring for the connecting part and dispensed with the sutures. His experiments on animals proved very successful. Guersant reported a successful case. Nélaton admires the perfection of the mechanism of this method, but makes the serious objection to it that the rings are not always at hand when needed, and that the passage of such a large foreign body is a matter of difficulty and might lead to fatal complications.

Baudens modified Denans' method by using a single cylinder with a deep transverse groove in the center and two rubber rings. The inverted margins of the bowel ends were fastened upon the cylinder by the rubber rings pressing in opposite directions towards the center of the groove on the outer surface of the cylinder. The inverted margins subjected to

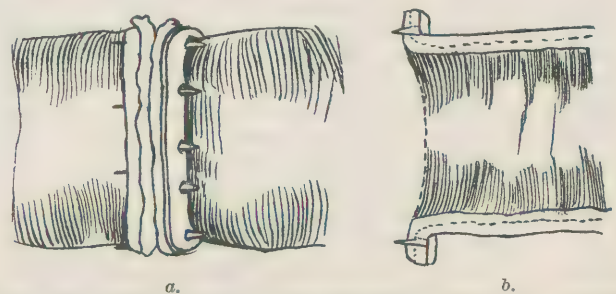


Fig. 35. Method of Henroz. a, One end of bowel with ring in situ; b, ends joined together between the two spiked rings; c, ring showing spikes and perforations for spikes of opposite ring.

the elastic pressure sloughed and came away with the cylinder and rubber rings.

Henroz clamped the two ends of the bowel together between two rings, each supplied with a number of sharp metallic points which transfixed the mucous membrane, and by taking hold in perforations in the ring on the opposite side held the rings together and fixed the bowel ends.

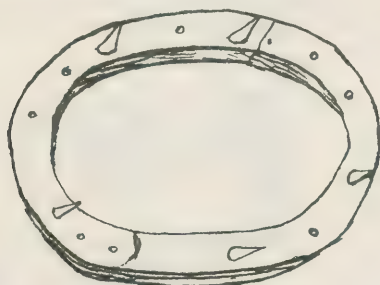


Fig. 35 c.

The great objection to this method is that the margins of the ends of the bowel were not inverted; union was effected with the mucous membrane turned outward, consequently it must have proved a failure even in experiments on the lower animals.

Somewhat similar mechanical contrivances that I have described above in the end-to-end approximation of the intestine have been devised in the treatment of longitudinal and incomplete transverse wounds.

Beranger-Feraud ("Des diverses méthodes de reunion des plaies intestinales," Paris, 1870), invented a clamp which he regarded as being especially applicable in the treatment of longitudinal wounds.

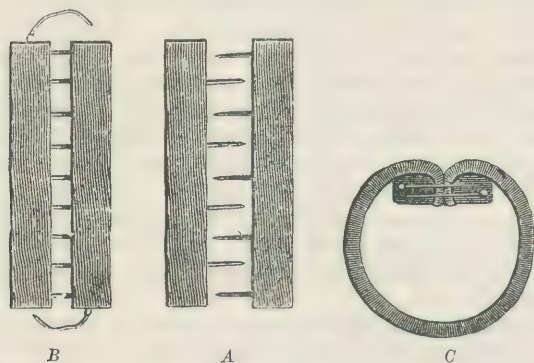


Fig. 36. Beranger-Feraud's cork clamp suture. a, clamp ready for use; b, clamp closed; c, clamp in place holding the serous surfaces of the inverted margins of wound in contact.

Two quadrangular prisms of cork 6 mm. in thickness and as long as the wound are prepared. Fine insect needles are pushed through these pieces of cork about 6 mm. apart, in such a manner that the heads well pushed into the cork are covered with sealing wax. One of the prisms is inserted into the wound, and the points of the pins are made to penetrate the entire thickness of the intestinal wall near the margin of the wound from within outward. After the other prism is in place, the serous surfaces are brought in contact by pressure from without against the prisms, so as to bury the points of the pins in the opposite piece of cork sufficiently deep to insure adequate pressure. The included parts slough away with the clamp; meanwhile adhesions form between the approximated serous surfaces outside of the clamp. For the purpose of giving greater security the two

pieces of cork can be fastened together in addition by a curved pin as is shown in Fig. 36, b.

Bobrick ("Med. Vereinszeitung," 1850), described another kind of clamp suture. The clamp is made either of sheet lead or a thin strip of silver the length of the wound. The metal strip is folded in the center in its long axis like the cover of a book, before it is inserted into the bowel through the wound. The margins of the wound are then inverted and engaged between the two leaves of the clamp, when by pressure from without the clamp is closed sufficiently firm to fix the parts included securely. Adhesions form in a short time on the surface outside of the grasp of the clamp, the included parts slough and escape with the clamp. The greatest objection against all the substitutes for the intestinal sutures that have been mentioned, is that a foreign body is left in the intestinal canal which necessarily constitutes an additional source of danger, because spontaneous elimination is attended by many difficulties and risks. In this regard the experimental results are not directly applicable to man. The intestinal canal of dogs is much shorter in proportion to the size of the body than that of man, and the muscular coat is much more developed. Dogs are reckless eaters, and for this reason they have been supplied with an intestinal canal that can dispose of foreign bodies of large size and most dangerous forms. This is not the case in man, hence leaving a foreign substance of any considerable size in the intestinal canal of man is fraught with danger.

That Lambert's method of treating intestinal wounds and its many modifications did not give universal satisfaction, becomes evident from a paper published by Privat in 1846. ("Bull. de Thérapie," Sept., 1846) Under the title of *Autoplastie* he described in this paper a new method of dealing with intestinal wounds which he successfully applied in a case of penetrating wound of the abdomen complicated by four intestinal wounds. The wounds were first sutured and fastened in the abdominal wound by mesenteric loops. The sutures tore through on the second day, when he fastened over each wound an adjacent intestinal loop. On the seventh day three of the wounds were closed and the intestine was returned into the abdominal cavity. The fourth wound was not quite closed and was retained in the external wound. It closed later and the patient made a perfect recovery. He is of the opinion that intestinal wounds can be healed more readily by covering them with an adjacent healthy loop than by suturing. It will thus be seen that in spite of great improvements over the ancient methods, the progress made did not answer the practical demands.

III—RECENT METHODS.

The second great improvement in intestinal suturing was the introduction of the aseptic suture by Sir Joseph Lister, nearly a quarter of a century ago. We can readily understand that the old septic suture was the direct cause of death in many cases in which the operation was faultlessly performed. Lister taught us to use aseptic material for the sutures and to apply the other principles of antiseptic surgery in the management of intestinal as well as other wounds. The adoption of this method of wound treatment removed a frequent source of septic peritonitis and added much to the success and rapid development of intestinal surgery. The aseptic suture in aseptic

tissues no longer constituted a source of danger. Under this plan of treatment absorbable sutures were removed by absorption, unabsorbable material became encysted without causing harmful irritation. The catgut suture that met at first with such a warm reception by surgeons in the treatment of intestinal wounds has been gradually displaced almost completely by the aseptic silk suture, so that at present but few surgeons rely upon it in the treatment of an intestinal wound. Czerny (Sammlung Klinischer Vorträge, 1881, No. 201) added another row of stitches to Lembert's sutures. He wished to approximate not only the peritoneal surfaces, but also the margins of the mucous membrane in order to prevent escape of intestinal contents between the parts brought in apposition by Lembert's stitches and to place the parts in an ideal condition for repair.

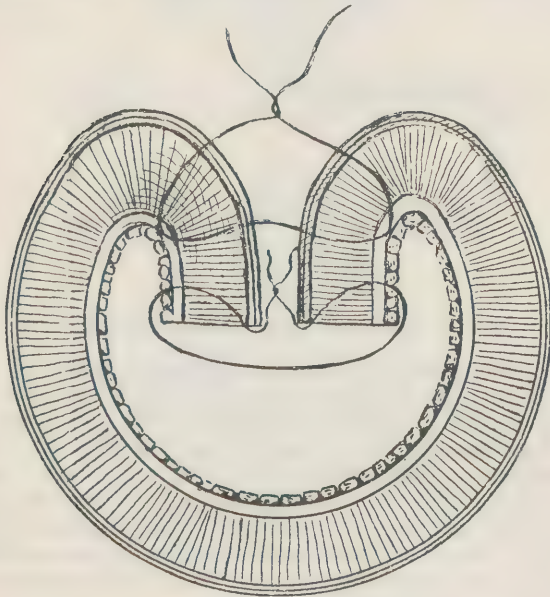


Fig. 37. Czerny-Lembert suture.

Czerny's modification of Lembert's method consists in uniting first the mucous membrane by a row of stitches, which, with the exception of the last one or two, are tied on the mucous surface. These stitches ulcerate into the lumen of the bowel, while the superficial or Lembert's stitches become encysted. In all cases in which two rows of stitches are used in closing a wound or in performing circular enterorrhaphy, this method is usually practiced. If time permits, this method is safer than any of the single row methods.

Gussenbauer devised a figure-of-eight suture which was intended to accomplish the same objects as the Czerny-Lembert suture.

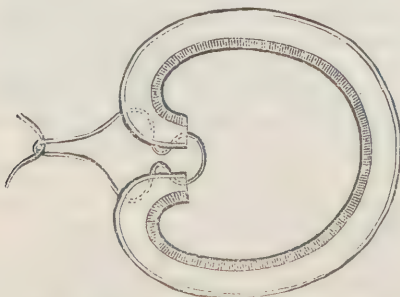


Fig. 38. Gussenbauer's suture.

It is much more complicated than the Czerny-

Lembert suture, and does not bring the parts in apposition as accurately, and for these reasons is seldom employed. In circular enterorrhaphy Wölfler sutures the mucous membrane from the inside of the bowel, brings the serous surfaces in contact by Lembert's stitches and, if necessary, applies over these a continued suture of fine silk or catgut.

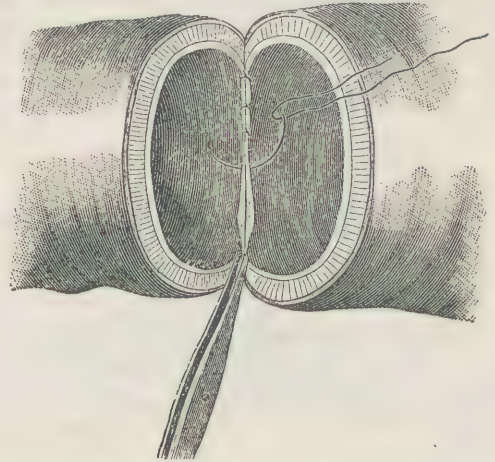


Fig. 39. Wölfler's suture. a, Deep sutures; b, superficial sutures.

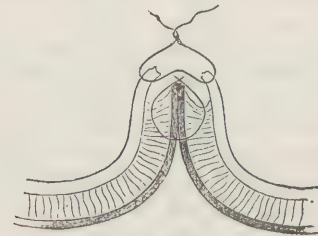


Fig. 39 B.

Madelung (Verh. d. Deutschen Gesellschaft f. Chirurgie, 1881) used in circular suturing small discs of cartilage made from the costal cartilage of a calf, with which he aimed to secure better approximation between the serous surfaces than by the unaided suture alone.

Bishop (*Medical Chronicle*, September, 1885) has devised and successfully employed in the lower animals an ingenious, and in his experimental work a satisfactory suture. It is a kind of interrupted shoe-maker's stitch introduced on the mucous side, each suture loop being tied on alternate sides of the line of junction.

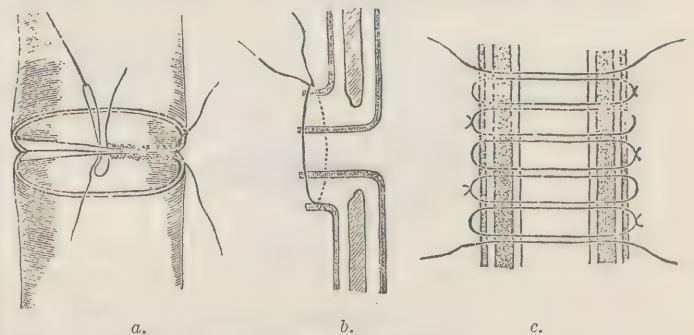


Fig. 40. Bishop's suture.

The stitches are all on the mucous side of the bowel, and as they tend to produce too much narrowing of the bowel the method will never receive the sanction of the practical surgeon.

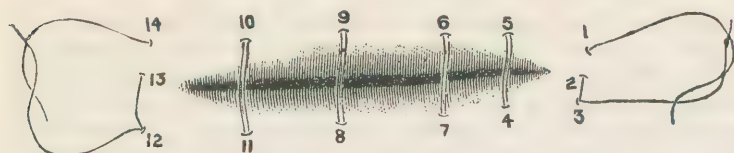


Fig. 41. Greig Smith's modification of Appolito's method.

Greig Smith's modification of Appolito's suture consists in doing away with the necessity of placing a foreign body in the intestines to which the end of the suture is attached. Smith credits this suture with giving wonderfully good apposition.



H. W. Cushing ("Right Angle" Continuous Intestinal Suture. Medical and Surgical Reports of the City Hospital of Boston, 1889) has still further modified Appolito's method, and has perfected it to such an extent that it has become one of the sutures that is entitled to general recognition. The first stitch is knotted as soon as a hold upon the bowel has been obtained, and the right angle stitches are now commenced. The thread is then carried to and fro across the wound, and is finally knotted at the opposite side of the wound. The author of the exceedingly interesting pamphlet from which these facts are gleaned says: "The most satisfactory results are obtained in the human intestine by placing the points of puncture one-eighth of an inch apart, and by burying the suture to the same extent in a direction parallel to, and three-sixteenths of an inch distant from the wound edge. The suture terminates in the tough, fibrous submucous layer, and is not intended to involve the mucous membrane or penetrate the intestinal cavity. Each part of the suture should be drawn tight, so as to accurately appose the wound edges before the next is set."

Halsted's (*International Journal of Medical Sciences*, October, 1887) plain quilt suture is a compromise between Emmert's and Cushing's suture.

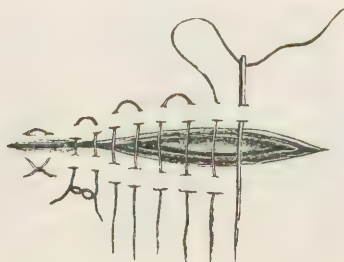


Fig. 43. Halsted's plain quilt suture.

He places great stress upon the importance of including in the sutures a few of the firm fibers of the submucous coat, which he has studied so carefully and described so well. He claims for this suture that it does not strangulate the tissues so much and

obtains a firmer hold than the Lembert stitch. It is, however, a more time-consuming procedure than the ordinary method by Lembert stitches and more confusing to the inexperienced surgeon. The mucous membrane has always been in the way of the surgeon in dealing with intestinal wounds. Moreau and

Poutard excised the prolapsed mucous membrane before suturing, in order to prevent the interposition of this structure between the peritoneal surfaces and to secure a wider surface of healing. Kummer (*Verhandlungen d. Deutschen Gesellschaft für Chirurgie*, 1891, p. 121) has carried this procedure farther and under the name of submucous resection of the intestine, he describes a form of circular suturing in which a circular strip of the mucous membrane half an inch wide is excised on each side prior to bringing the parts in apposition by sutures.

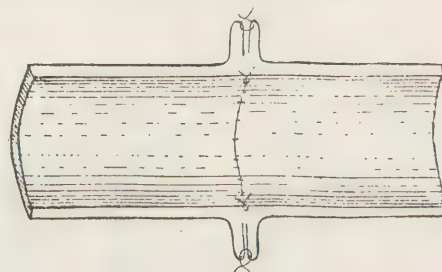


Fig. 44. Kummer's method of circular suturing.

The mucous membrane is sutured separately on the inner side of the bowel; the remaining part of the bowel wall appears in the form of a ridge, which after inversion of the peritoneal surfaces is sewed separately. The lumen of the bowel is not narrowed at the seat of suturing, and an extensive area of wound surface is included by the sutures. The method, however, is objectionable as it necessitates a maximum degree of traumatism and consumes too much valuable time.

Chaput (*Congres Francais de Chirurgie*, 1889) does not excise the whole mucous membrane, as just described in Kummer's method, but removes only the epithelial lining by scraping. The mucous membrane is everted and a circular strip one centimetre wide on each side is denuded with a sharp curette. In sewing them together he brings in contact the scraped surfaces and covers the line of suturing with omentum. The invagination method, after scraping off the lower end in a similar manner, yielded such bad results in his experiments on dogs that it was never tried on man.

Robinson (*Annals of Surgery*, 1891) described a new method of end-to-end suturing. A rubber tube from four to six inches long is inserted into the proximal end and stitched around the edge. The mucous membrane of the distal end is dissected off with curved scissors and then curetted for about one-half inch. The proximal is then invaginated into the distal end, so that the peritoneal surface is in contact with denuded mucous membrane. A row of stitches around the circumference of the distal end, which, however, does not penetrate the lumen of the proximal bowel, completes the operation.

M. E. Connell (*Medical Record*, September 17, 1892) has made some very interesting experimental investigations in circular enterorrhaphy with a special view of reducing the number of stitches and knots.

After a circular resection the cut ends of the bowel are placed in position represented by Fig. 45 *a*, and the first or tight suture is inserted, as shown by *b*. After tying this suture the parts will represent the appearance as in *c*. In making the second or loose suture, the needle is inserted from without inward through the wall of the bowel, at the convex end,



Fig. 45. Connell's suture for circular enterorrhaphy.

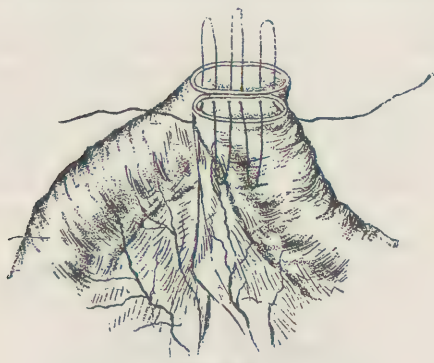


Fig. 45 B.



Fig. 45 C.

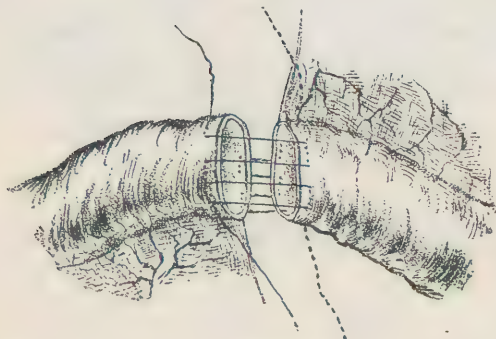


Fig. 45 D.

and passed out again on the same side; it is then crossed over the cut edges to the opposite wall, and a stitch is taken through all the coats about three sixteenths of an inch in length, parallel with the

margin of the cut edges; it is now passed back again and a stitch is taken as before. This is repeated until enough stitches have been taken when the needle is brought from within outward through the mesenteric end. When this suture has been inserted, and before it has been drawn tight, it appears as in *d*. When the suture is tightened the margins are inverted and the serous surfaces approximated.

Maunsell, of New Zealand, ("A New Method of Intestinal Surgery."—*American Journal Medical Sciences*, March, 1892), has devised a method of circular suturing in imitation of nature's processes in the spontaneous cure of an invagination.

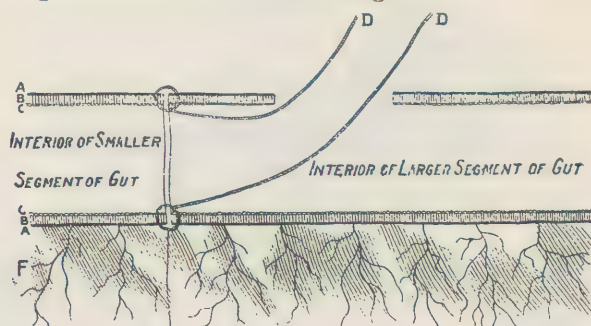


Fig. 46 A. Longitudinal section of gut showing AA, peritoneal coat. BB, muscular coat. CC, mucous coat. DD, temporary sutures passed into bowel and out through longitudinal slit made in larger segment of gut. F, mesentery.

The two ends of the bowel are brought together with two temporary sutures passed through all the coats of the intestine. The long ends of these sutures are left intact. One is placed at the mesenteric attachment, and the other at a point directly *vis à vis*. These sutures are used later in effecting invagination. On the side on which the temporary invagination is to be made the bowel is incised to the extent of an inch and a half, on the convex side parallel to its long axis, as is shown in Fig. 46 *a*.

The edges of the longitudinal slit made in the bowel, which begins about an inch from its cut end, should be well turned in and brought together with continued suture of Lembert's stitches. By this simple device, the perfect union by suture of a complete transverse section of the bowel, with its circumferential peritoneal surfaces in exact position and all knots of the sutures on the inside, can be accom-

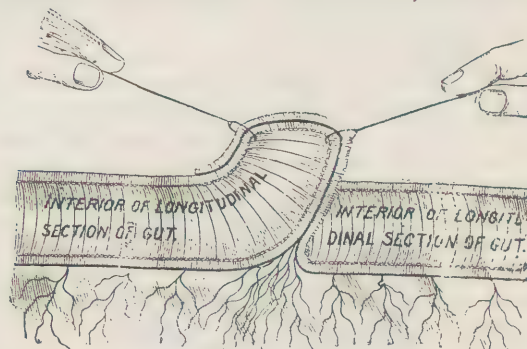


Fig. 46 B. Maunsell's artificial invagination and circular suturing.

plished. From diagram *b* (longitudinal section of intestine, showing the relative position of the different layers of the bowel invaginated at the longitudinal slit) it may be seen that the peritoneal surfaces are in accurate apposition all around. While an assistant holds the ends of the temporary sutures, the surgeon passes a long, fine, straight needle, armed

with a stout horse hair or a very fine silkworm gut through both sides of the bowel, taking a good hold of all the coats. The suture is then worked up from the center of the invaginated intestine, divided, and tied on both sides. *In this way twenty sutures can be placed rapidly in position with ten passages of the needle.* (See diagram c.) The temporary sutures

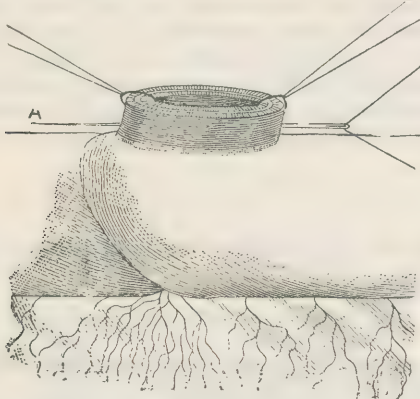


Diagram C. Invaginated gut, showing the two peritoneal surfaces in juxtaposition all around. A needle passed through both sides of the bowel, including all the coats, introducing two sutures with one passage of the needle.

are now cut off short, and the sutured ends of the bowel painted with Wölfler's mixture of alcohol, glycerin and colophonium, and dusted over with iodoform. The bowel is then pulled back. The longi-

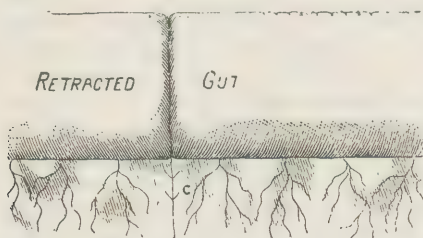


Diagram D. Appearance of bowel after completion of operation.

tudinal slit in the gut is well turned in and closed with a continuous suture and painted with Wölfler's mixture and iodoform powder. This method of suturing has yielded excellent results in experiments on animals and recommends itself for a careful study to every surgeon. A serious objection to this method is the additional wound through which the temporary invagination is made.

M. L. Harris ("Circular Enterorrhaphy; A New Method.")—*Chicago Medical Recorder*, September, 1892) has devised a new method of circular enterorrhaphy which in dogs has given excellent results. The distal end of the bowel is denuded of its mucous membrane for the distance of one and one-half to two centimetres with a sharp curette. The upper end is then invaginated into the lower in such a manner that the serous surface of the upper end comes in contact with the denuded submucous layer of the lower.

Three ordinary round sewing needles of a good length are threaded with fine sterilized silk. The first needle is made to transfix the thickness of the lower or denuded end of the bowel just to one side of the mesentery and at the inner limit of the denudation. It is not drawn clear through, but only until the point projects from the caliber of the bowel a little beyond its free edge. The point of the needle is made to pick up a bit of the other end of the

bowel, transversely, just to one side of the mesentery and very near to its edge, Fig. 47.



Fig. 47. Circular enterorrhaphy according to Harris. a, invagination suture.

Now, by drawing the needle back a little and using it as a lever by turning it around its point of transfixion in the lower end, it will be readily seen that the upper end, on this side, is invaginated into the lower end as far as the part is denuded of its mucous membrane. The point of the needle is then pushed on through the lower end from within outwards a short distance in a line transversely from the first point of entrance, where the needle is left temporarily, transfixing the bowel and holding that part of



Fig. 47 B.

the upper end invaginated. Fig. 47, b. (b, partial invagination.) The same process is repeated with the second needle at a corresponding point of the bowel on the opposite side of the mesentery, while the third needle is used similarly at the part of the bowel opposite to the mesenteric attachment. As will be observed (Fig. 47, c), there are two rows (c, operation completed) of sutures around the bowel,

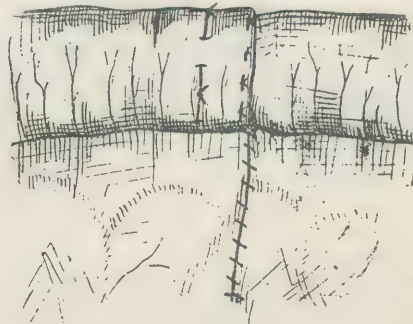


Fig. 47 C.

one at either end, thus permanently keeping the opposed surfaces in accurate contact regardless of the varying caliber of the bowel. It is the first row of sutures around the invaginated end to which the success of the method is due, and it was because Chaput failed to recognize it in his invagination method that his operation was a failure and every one of his animals died. Harris is of the opinion that it is not material in which direction the invagination is made when this method is employed. Although all of the animals operated on by this method lived and the specimens obtained later showed excellent results, I cannot but believe that any method which deviates from the principles established by Lembert is a step in the backward direction, and that few if any surgeons will have the courage to deviate from them when called upon to assume the responsibilities of such operations on his fellow-beings.

The tendency has recently been toward the employment of some kind of an aid or substitute for sutures in effecting an end-to-end union of the intestine. Senn ("Intestinal Surgery," Chicago, 1889, p. 168), has modified Jobert's method of invagination by substituting catgut for silk for the invagination sutures and by lining the upper end of the bowel with a flexible rubber ring. The operation is described as follows: "The upper end of the bowel which is to become the intussusceptum is lined with a soft pliable rubber ring made of a rubber band, transformed into a ring by fastening the ends together with two catgut sutures. This ring must be the length of the intussusceptum, from one-third to half an inch; the lower margin is stitched by a continuous catgut suture to the lower end of the bowel, which effectually prevents the bulging of the mucous membrane, a condition which is always difficult to overcome in circular suturing. After the ring is fastened in its place the end of the bowel presents a tapering appearance which materially facilitates the process of invagination.

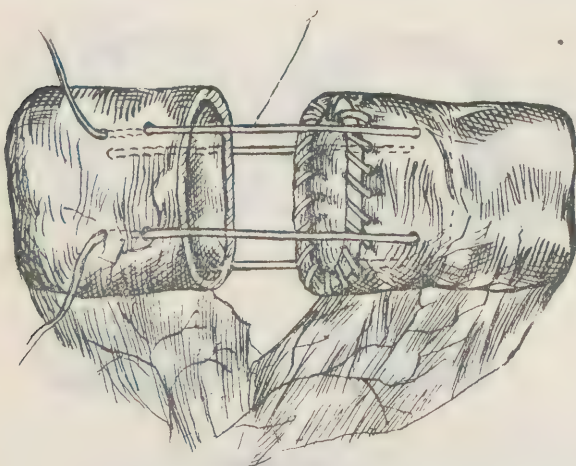


Fig. 48. Senn's modification of Jobert's invagination method. *a*, upper end lined with ring, invagination sutures in place; *b*, lower end; *c*, invagination completed, sutures tied.

"Two well prepared fine chromicized or juniper catgut sutures are threaded each with two needles. The needles are passed from within outwards, transfixing the upper portion of the rubber ring and the entire thickness of the wall of the bowel and always equidistant from each other; the first suture being passed in such a manner that each needle is brought out a short

distance from the mesenteric attachment, and the second suture on the opposite convex side of the bowel. During this time an assistant keeps the opposite end of the bowel compressed to prevent contractions and bulging of the mucous membrane. The needles next are passed through the peritoneal, muscular and submucous coats at corresponding points about one-third of an inch from the margin of the opposite end of the bowel, and when all the needles have been passed an assistant makes equal traction on the four strings, and the operator assists the invagination by turning in the margin of the lower end evenly with a director



Fig. 48 C.

or probe, and by gently pushing the rubber ring completely into the intussusciens. The invagination is accurately made, the two catgut sutures are tied only with sufficient firmness to prevent disinvagination should violent peristalsis follow the operation. The invagination itself effects accurate, almost hermetical sealing of the visceral wound. The intestinal contents pass freely through the lumen of the rubber ring from above downwards, and extravasation from below is impossible, as the free end of the intussusciens secures accurate valvular closure. After a few days the rubber ring becomes detached, and by giving way of the catgut sutures is again transformed into a flat band, which readily passes off with the discharges through the bowels. The invagination sutures of catgut are gradually removed by substitution on the part of the tissues, hence the punctures in the bowels remain closed either by the catgut or by the products of local tissue proliferation; and thus extravasation is prevented."

Neuber used a hollow cylinder of decalcified bone with a deep groove in the center as an aid in circular enterorrhaphy. (Fig. 49, *a*.)

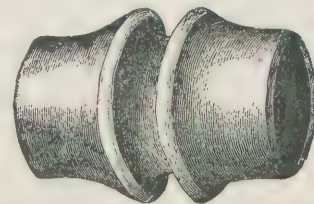


Fig. 49. Neuber's method. *a*, hollow cylinder of decalcified bone; *b*, longitudinal defect in bowel, showing location of cylinder, sutures, and catgut ligature.

After suturing the mucous membrane according to Wölfler's method so far that only an opening is left large enough to insert the cylinder, this is introduced in such a way that the transverse groove cor-

responds with the line of suturing when the serous surfaces are brought in contact by Lembert sutures. In order to fasten the united bowel securely upon the bone tube, a catgut thread is passed with a round needle through the mesentery, and tied around the bowel with sufficient firmness to press the margins of the sutured ends of the bowel into the groove. (Fig. 49, b.) This method has been employed in a number of cases with good results.

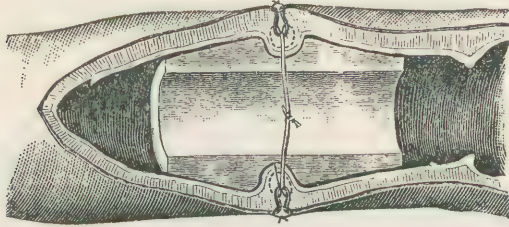


Fig. 49 B.

One of the most recent devices to take the place of sutures in restoring the continuity of the bowel in complete transverse wounds is the Murphy button. (*New York Medical Record*, December 10, 1892.) It is an exceedingly ingenious appliance, but its mechanism as far as uniting the ends of the bowel is concerned is no improvement upon the rings employed

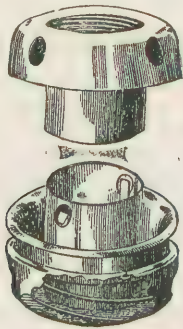


Fig. 50. Murphy's button.

by Denans more than half a century ago. In both methods the margins of each end of the bowel are compressed and strangulated by the instrument with the intention of causing gangrene, and the resulting union is accomplished by adhesions between the serous surfaces outside of the grasp of the instrument. Both methods have also this in common, that a large foreign body is left in the intestinal canal which may become a source of danger on its way to the distal end of the alimentary canal. There is substantial ground for the two pertinent questions propounded by Henry Morris (*International Encyclopedia of Surgery*, 1884, p. 944) in commenting on the procedure of Denans: "Who would venture to leave the intestine in this manner in the belly? Who would guarantee that the metallic tubes would not perforate the intestine?" Any instrument, suture or ligature used in effecting the continuity of a wounded or divided bowel that produces gangrene must be looked upon as a source of danger. It is impossible to effect an aseptic necrosis in the interior of the bowel, and dead tissue inhabited by pathogenic microbes always constitutes a source of danger. It is easy enough to produce gangrene, but we are powerless in limiting its extension in this locality. The limited area of living tissue brought in contact outside of the rings of Denans

or the Murphy button will not always prove adequate in the protection of the peritoneal cavity against perforation and its immediate result—septic peritonitis. I have knowledge of a number of cases in which the parts approximated by the Murphy button were found completely separated at the post-mortem examination. As a means of end-to-end union of the intestine, the Murphy button is certainly inferior to Denans' procedure or the method that will be next alluded to, because the lumen of the connecting part is not large enough as a temporary outlet for the intestinal contents above the seat of operation. The size of the button is also a very serious objection. I have operated for intestinal obstruction produced by a gallstone less than an inch in diameter which had become impacted in the lower end of the ileum, and other surgeons will recall similar instances. Keen (*Annals of Surgery*, June, 1893) gives the post-mortem record of a case of malignant disease of the colon in which an anastomosis was established by using a Murphy button one inch in diameter. The patient survived the operation forty-seven days. The anastomotic opening had become reduced one-half in size by contraction during this time. In a postscript he says: "The button should be abandoned for intestinal or gastro-intestinal anastomosis."

If this warning of so eminent a surgeon foreshadows the final verdict of the profession in regard to the use of the button for anastomotic purposes it will never come into use in end-to-end approximation.

A few days ago I received an interesting brochure from Adelbert Ramaugé, professor of surgery in the medical faculty of Buenos Ayres, entitled "Enteroplexie," a paper which he read at a meeting of the International Medical Congress of South America, January 20, 1893, and which received the first prize, a gold medal, from the Peruvian government. In this paper I find the description of an instrument which is intended for the same purpose as the Murphy button and which bears a strong resemblance to it.

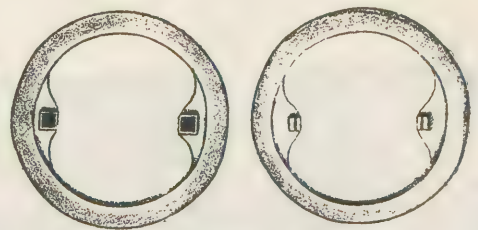


Fig. 51 A.



Fig. 51 B.

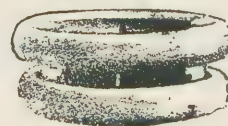


Fig. 51 C.

Fig. 51 A. Ramaugé's method of end-to-end approximation. a, platinum rings, front view; b, platinum rings, side view, showing male and female connecting parts; c, rings joined together; d, longitudinal section of bowel, showing position of rings and included parts.

Its mechanism as far as the end-to-end approximation is concerned is the same as that of the button.

The rings are made of aluminium. The connection between the rings is made by two instead of one part. This is a decided advantage, as the size of the temporary outlet is thereby increased. As the rings are composed of aluminium, they are much lighter than the button, and for this reason less likely to

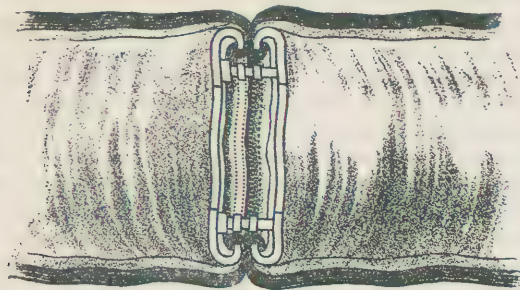


Fig. 51 D.

become arrested on their way through the intestinal canal. The objections which have been made against Denans' rings and the Murphy button otherwise apply with equal force to this procedure.

The revival of intestinal anastomosis by Billroth and Senn has opened up a new field for experimentation with different kinds of sutures and their substitutes. The author ("Intestinal Surgery," Chicago, 1889) made many operations on dogs by suturing the two visceral wounds which were intended to form the anastomotic opening by the Czerny-Lembert method, and notwithstanding that the greatest care was exercised in carrying into effect the antiseptic details, and with a view of a perfect technique, nearly 50 per cent. of the animals died, either from the immediate effects of the operation or from complications resulting from the operation. For the purpose of gaining time and doing away with the evil accruing from too many sutures, and finally with the intention of securing a greater surface of approximation of the serous surfaces and complete rest for the parts it is



Fig. 52. Senn's method of performing intestinal anastomosis. *a*, perforated decalcified bone plate with sutures attached; *b*, plates inserted through longitudinal slit in bowel on each side of obstruction; lateral ligatures passed through margin of wound on each side; *c*, the four approximation sutures tied, cut short to the knot, and serous surface over margins of plates sewed together with continued suture.

intended to unite, he substituted for the sutures approximation plates. The idea was suggested to him by Dr. M. E. Connell, superintendent of the Milwaukee County Hospital. The first experiments were made with plates of wood, lead, gutta serena and other indestructible substances, nevertheless nearly all of the animals recovered. The material for the plates that was found the most useful after many trials was decalcified bone. The appearance of the

plates and their method of use in making an intestinal anastomosis are well shown in the accompanying illustration taken from the last edition of Esmarch's "Chirurgische Technik."

The serous surfaces included between the plates are scarified for the purpose of securing early and firm adhesions. The plates furnish the necessary mechanical support until firm adhesions have formed when they disintegrate and pass away in fragments. The two lateral sutures fall into the lumen of the bowel. The mistake was first made in operations on man in making the perforation in the plate and the longitudinal wound in the bowel too short, hence the anastomotic opening was too small from the beginning. For gastro-enterostomy and intestinal anastomosis, I now use moist plates (kept between glass plates in an antiseptic solution) with a perforation at least three inches in length and make the visceral wounds correspondingly long. Since I have adopted this change, I have had no trouble with the anastomotic opening. Different kinds of material have been substituted for the decalcified bone. Abbe and Matas used catgut rings, Brokaw segmented rubber ring, Robinson rawhide and segmented rubber plates, Davis catgut mats, Stamm cartilage plate, Shrively and Simonson chromicized gelatin plates, Dawbarn potato plate, von Baracz Swedish turnip plate, and a French surgeon has recently proposed plates made from shavings of the hoofs of horses. H. Littlewood (*The Lancet*, April 16, 1892) has suggested a modification of Senn's plates, with the idea of doing away with the four stitches attached to the upper and lower margins of the apertures of the plates, of performing the operation more quickly and of ensuring a good opening between the two pieces of the intestine.

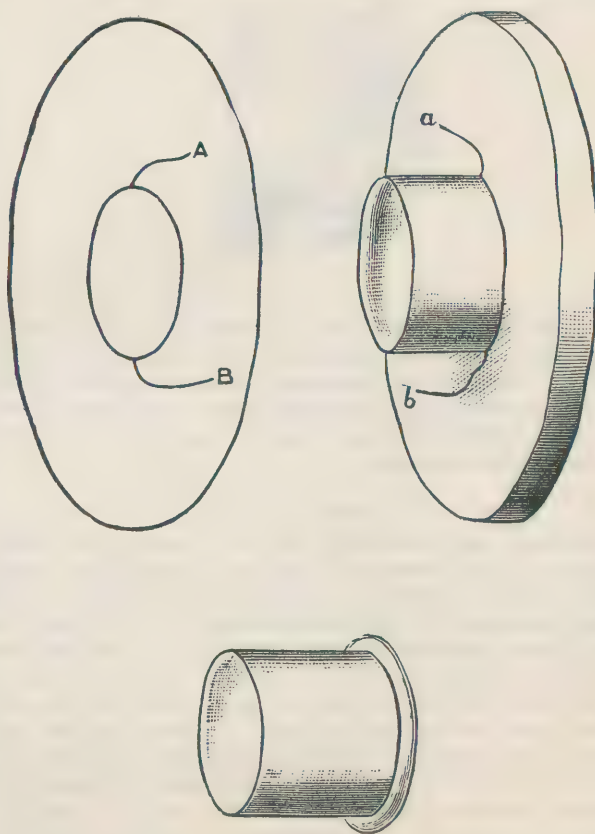


Fig. 53. Intestinal anastomosis after Littlewood. *a*, decalcified bone plate, central opening for connecting tube; *b*, decalcified bone plate with connecting tube inserted; *c*, connecting cylinder.

The suggested modification is to fix a tube of decalcified bone (*c*) into the aperture of one of the plates (*b*). This should be made to accurately fit into the aperture of the other (*a*); by this method the two plates could be held together, and the two parts of the intestinal walls between them brought evenly into contact with each other. He suggests that it might be well to have a piece of fine silk attached to each of the ends of apertures (as marked *A a*, *B b*, in diagrams *a* and *b*), so that by tying *A a* and *B b* together greater security would be made. The intestinal walls around the margins of the plates should be attached by a few sutures.

Willy Sachs (*Centralblatt f. Chirurgie*, October 4, 1890) has described a very similar modification. He proposes the use of an appliance resembling in form a sleeve stud, perforated in the middle. This is made up of two decalcified bone plates fixed together, yet separated to a small extent from each other as far as the uniting portion immediately around the central portion. A longitudinal incision having been made in each of the opposed portions of intestine, each disc is inserted into the intestinal canal on either side, and the intestinal anastomosis is thus readily and speedily established. Sutures are then applied through the serous coat on each side wherever there is a tendency to protrusion of the mucous membrane. He tested this method so far only on rabbits.

A. W. Mayo Robson ("A Method of Performing Intestinal Anastomosis by Means of Decalcified Bone Bobbins."—*British Medical Journal*, April, 1893), uses a contrivance very similar to that of Sachs' which he calls decalcified bone bobbin. He has used this method with success in two cases.

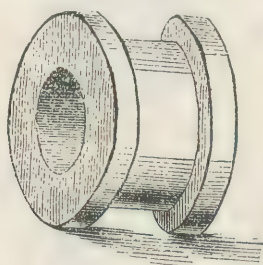


Fig. 54. Robson's decalcified bone bobbin.

In making an intestinal anastomosis, each end of the tube is inserted into the bowel through a longitudinal incision and fastened to the connecting portion by a continued marginal suture. After this has been done on each side the serous surfaces are united by superficial sutures.

IV—PRESENT STATUS.

Enough has been said on the history and technique of the intestinal suture to show how much study, time, ingenuity and experimentation have been expended in its perfection, and yet the task has not been completed. The search for new sutures and their substitutes at the present time is sufficient proof that perfection has not been reached. Deviation from the legitimate path of investigation has done much towards retarding genuine progress. In this light must be viewed all attempts to ignore the principles established by Lambert and the employment of such foreign substances in the intestinal canal as means of approximation that necessarily produce gangrene, and of sufficient size to constitute

an intrinsic source of danger. In the treatment of longitudinal and incomplete transverse wounds suturing by Czerny-Lembert sutures yields the best results. If time is an important factor a single row of Lembert stitches will answer the purpose. About six sutures to the inch are required. Halsted's advice to include in the stitches fibers of the firm submucous coat is important and should never be ignored. As a rule the line of suturing should be transversely to the long axis of the bowel in order not to encroach too much upon its lumen. Fine aseptic silk and ordinary sewing needles are to be employed. The inner row of sutures must include all tunics of the bowel with the exception of the peritoneum; the outer all of the tunics minus the mucous membrane. The inner sutures ulcerate through into the bowel, the outer become encysted. Interrupted sutures are safer than the continuous, but in prolonged operations and when the patient is feeble, the latter can be substituted for the former as a time saving measure. Extravasation during the operation is best prevented by digital or elastic compression on each side of the wound. The latter is made by passing a piece of fine aseptic rubber tubing through an opening in the mesentery made with a piece of hemostatic forceps, and tied around the bowel sufficiently firm to prevent escape of its contents.

If the bowel is completely divided its continuity can be restored with the greatest degree of safety by circular enterorrhaphy or invagination by the author's method. The latter is not applicable in operations for intestinal obstruction, as in that case the upper end of the bowel is larger than the lower into which the invagination must be made. Before suturing is commenced each end of the bowel should be beveled at the expense of the convex side, as advised by Madelung many years ago, as by doing so there is less danger of the sutures causing a dangerous degree of stenosis and the liability to marginal gangrene on the convex side is also greatly diminished thereby. If the lumina of the bowel ends are unequal in size, the obliquity should be greatest on the side of the small end. Circular suturing is performed in the same manner as suturing of incomplete wounds. The greatest care is required on the mesenteric side, as it is here where perforations occur most frequently. After applying the deep row of sutures the first Lembert stitches are applied on each side of the mesenteric attachment in order to secure serous approximation in this locality. The Lembert stitches must be tied only with sufficient firmness to approximate the serous surfaces without subjecting the included tissues to harmful linear compression. Puncturing of visible vessels should be avoided as much as possible. The mesentery is sutured in such a manner that it will aid in holding together the sutured end. Senn ("Intestinal Surgery," Chicago, 1889) has proposed and practiced omental grafting as a valuable aid in circular suturing. This additional protection against perforation and peritonitis is especially indicated when the tissues at the place of suturing have undergone pathological changes in consequence of intestinal obstruction or inflammation. A strip of omentum about an inch wide and long enough to cover the entire circumference of the bowel is used for this purpose. Prior to planting the graft the serous surface of the bowel half an inch from the line of sutures on each side is scarified, and the under surface of the graft is dealt

with in the same way. The graft is fastened by two catgut sutures on the mesenteric side, including the mesentery and both ends of the graft. The stitches are made parallel to the mesenteric vessels. The grafts become firmly adherent within a few hours, and in the course of one or two days are vascularized by new vessels growing into them from the scarified surface of the bowel. If any internal aids to circular suturing are used they should be composed of absorbable material and employed in such a way as not to produce marginal gangrene, and with a central opening large enough to allow free fecal circulation. I cannot but regard mechanical supports made of metallic substances as dangerous. The objections made to them do not apply with equal force to the decalcified bone tube of Neuber, the sleeve button of the same material, of Sachs and Littlewood, and the bobbins of decalcified bone of Robson. These appliances merit a trial and will undoubtedly be improved upon in the future.

Lateral anastomosis as a surgical procedure has a great future. I still remain partial to the use of decalcified bone plates as a substitute in part for

sutures. Abbe has discarded the use of his catgut ring and now advocates long incisions and suturing. If the plates are made with an oval perforation three inches in length the same object is realized in a much shorter time and with a greater degree of safety. I never had any faith in rings as a means of approximation. The plates bring into accurate contact large serous surfaces and serve at the same time as splints for the injured part. They serve the double purpose of sutures and splints. The other appliances of decalcified bone that have been enumerated may answer the same purpose as the anastomosis plates, but with none of them can the pressure to which the included margins of the visceral wounds are subjected be regulated with the same degree of certainty, and none of them approach so near the function of splints. I have no doubt that future experiments will result in the discovery of other and safer appliances that will be vastly superior to anything I have mentioned, and that if they do not abolish, will at least greatly limit the present field of the intestinal suture.

